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GROWING EXPORT TRADE.

The detailed figures now obtainable as to the United States export trade for 1899 are very encouraging. It appears that the importations of raw material for manufacture increased 33 per cent. over 1898, and that the grand total of manufactures exported reached $380,000.000. As compared with 1898, last year showed a gain of nearly $75,000,000 in this important class of exports in which the merchants and artisans of this country are so deeply interested. Products of iron and steel went up from $82,771,550 to $105,689,645; instruments and scientific apparatus from $3,317,980 to $5,695,730, and glass and glassware from $1,289,919 to $1,716,843. Copper and its manufactures increased from $34,789,808 to $43,102,665. These are notable gains, and the general percentage shows manufactured goods to have been 30.4 per cent. of the total exports as compared with 24.9 in 1898.

If we turn to some special portions of the globe we find American trade even more remarkably active than the above figures would indicate. For example, it is shown that with the Far East we have made a gain of 256 per cent. in exports during the last decade, with a gain of but 36 per cent. in imports. The increase in exports of iron and steel and in instruments and apparatus was more particularly to Japan. It would seem that even these striking figures can be increased, for with the growing wealth and population of this country we can take more imports in the next decade, and thus enable our customers in turn to develop their dealings with us. With Africa pacified at both ends, the Philippines restored to tranquility, China opened up and Central Asia made into section lots for the Siberian railroad, no doubt can exist as to the magnitude of the new opportunities for export trade, added to the enormous ones now existing with the countries of Europe, South America, Australia and the Far East, in every one of which quarters our commercial intercourse is daily being strengthened and expanded.

But much remains to be done in all these matters by our own efforts. As it is well put by Mr. D. A. Tompkins, of Charlotte, N. C., one of the vice-presidents of the National Association of Manufacturers: "What export trade the United States has built up with the East has been built up under adverse conditions. We have no cable across the Pacific; we have failed to build as yet the Nicaragua canal; we have failed to foster by subsidies larger, better or faster steamers for carrying the Pacific mails; we have failed to establish American banks in Yokohama, Shanghai, Hong Kong and Manila, having connections with the great American banks on this side of the Pacific; we have failed to put on exhibition at some central point like Shanghai a first-class exhibit of American goods; we have failed to ascertain thoroughly what classes of goods the East needs and prepare to make them; we have failed to perfect our consular service by putting it wholly under civil service regulations." Mr. Tompkins enumerates other points of omission, but the above are enough for immediate attention. He who would have friends must show himself friendly, and he who would have customers must go out and seek means for making them.

AN EXHIBITION OR WAR.

Many of our brethren of the daily press are frequent with their intimations that if the French nation had not got a great exhibition on its hands this year it would have plunged Europe into war long ere this or would have indulged in civil conflict. This may or may not be yellow journalism, whose if and buts are all portentous, but it strikes us as being anyhow a sensational assumption of the worst kind. France has an immense fund of conservatism in its make-up that is the more creditable when it is considered how sensitive and quickwitted her people are. But if the theory were true, what an immediate solution were found to the problem of abolishing war! What a pity it was that industrial exhibitions were not going on in London and Pretoria last year! Indeed it may be questioned whether, if we had had a Pan-American exposition in New York in 1898, the Spanish war would have broken out. Our own idea has been that wars followed rather that preceded exhibitions, but that is because the succession is not kept up. What is really needed is not a Hague Peace Conference, followed at once by a Double-Dutch war for freedom, between parties who represent all that Europe once knew of freedom, but an international show in some great capital every year. It is certain that when Buffalo celebrates next year, we can't dream of British gunboats swarming up the St. Lawrence or Germany flinging her fleet against South America. If Japan wants to fly at Russia, let us ask her to spend the money instead at Buffalo, and then have the next show herself at Tokyo.

ELECTRIC TRACTION FOR THE BERLIN, GERMANY, ELEVATED RAILWAYS.

In another page will be found described the main features of a system of electric traction proposed for the elevated railways of Berlin, Germany. The system is in many respects identical with the Sprague system, which in Chicago has proven so successful after a period of service sufficiently lengthy to establish its thorough reliability. The Sprague system in its entirety possesses three main features—the distribution of the weight of the motive apparatus of a train so as to render possible a maximum rate of acceleration; the simultaneous control of the motors of all the units of a train; and the independence of each unit, thus enabling the length of trains to be varied at will and in a few moments to suit the condition of traffic at any hour of the day. The proposed Berlin system incorporates the two first-mentioned features, but fails to take advantage of the third. The acceleration curves accompanying the article illustrate the enormous superiority for quick schedule service of electric traction—not from any innate virtue in the source of energy, but from the flexibility of its application allowing of an ideal distribution of tractive weight. What this advantage amounts to practically is well shown in the case of the Berlin roads. The limit of traffic with steam traction has been virtually reached, but by the adoption of the electric system proposed, the capacity of the road will be more than doubled. Our readers will find in the details of distributing system much to interest them. While these differ very considerably from the provisions made for the New York and Boston elevated roads, they have apparently been well considered with respect to the conditions existing in Berlin.

THE HUNTING OF ALTERNATING-CURRENT MACHINERY.

Referring to the contribution of Mr. W. L. R. Emmet, which recently appeared in these columns, in the issue of Jan. 20, there will be found in this issue a letter from Mr. F. G. Sykes, giving the experience which has been gained in this line in the famous Brooklyn Edison central polyphase generating plant. In this case it appears that the same remedy that is proposed by Mr. Emmet was adopted some two years ago, by simply using heavier oil in the governor dashpot and thus rendering more sluggish the governor of one of the units to be paralleled. Mr. Sykes also points out again the well-known necessity of some device for bringing down the speed of the unit running light to that of the unit running loaded, by throttling, or preferably by temporarily forcing the governor to a lower speed.

Mr. Emmet's analysis of the case undoubtedly accounts for the fact that in many instances trouble from hunting or pumping has not been experienced, while in others the trouble has been serious. In the former the engine governors are probably more sluggish than in the latter. While this cure is of value in preventing hunting between generators it gives no apparent clue to any means of preventing the more serious hunting which frequently occurs between rotary converters. That this hunting is not necessarily the result of the action of the engine governor is proved by the fact that it often occurs in plants driven by water power, and is altogether too rapid to be followed by any movement of the sluggish gates of turbine wheels.

THE INDUCTION MOTOR.

Elsewhere in this issue we print the first part of a paper on the induction motor, read by Mr. Ralph D. Mershon at the recent annual meeting of the Northwestern Electrical Association—a paper which will well repay perusal by those who desire to understand the underlying principles of this very interesting piece of apparatus. As will be seen, Mr. Mershon in his explanation correlates the actions of the induction motor with those which occur in the direct-current motor. This point of view is certainly preferable to that which involves consideration of a rotary field, for the reason that it is based upon primary actions while the latter has reference to resultants, and is therefore of little assistance to those accustomed to deal not with abstractions, but with primory principles. Indeed, it is doubtful if the rotary field hypothesis is of any value to any one, for mathematically the actions of the induction motor can be much more satisfactorily dealt with by considering it a type of transformer.

Mr. Mershon very properly lays much stress on the analogy between the direct-current shunt motor and the induction motor. This analogy is very close, and once having realized that the current in the armature performs the same office whether introduced from an external source by brushes or from an internal one by induction, it is not difficult to correlate the actions of the two machines. In the shunt motor a decrease of the load torque results in a surplus of the torque due to the action of the armature current and the field, which causes an acceleration of speed resulting in an increase of counter e. m. f., which cuts the current down to a point where there will again be a balance between the load and armature torques. Similarly, in the induction motor a decrease of load causes an increase of field cuttings, which finally brings down the current set up in the armature by induction until a balance is reached. In a shunt motor at no load the speed is a maximum, and only sufficient current flows to overcome friction, assuming no electrical losses. In the induction motor this maximum speed corresponds to synchronism, nearly. If there were no losses at no load, the current which the transformer action of the poles would tend to set up while a point on the armature moved from one pole to another, would be balanced by the motion of the coil between the two poles through the cutting of the same lines upon which induction depended. As the shunt motor can never reach its ideally maximum speed owing to losses in motion, neither can the induction motor attain synchronous speed; and with increase of load there is lag of speed in each case, this lag being called slip in the case of the induction motor.

It follows from the above that the speed of the induction motor can be varied in the same as that of the shunt motor. In either case the insertion of resistance in the armature tends to cut down the

current. But if the load remains constant, the torque cannot be changed; and as the torque is the effect of the two factors of field magnetization and the armature current, of which factors the former is necessarily constant, the current must also resume its former value. This can only occur through a reduction of the counter e. m. f., which thus involves a definite decrease in speed. It might seem that the necessary reduction of the current in the induction motor could be accomplished by the insertion of an inductance in the armature circuit, thus giving it an advantage over the direct-current shunt motor, which necessarily requires to reduce speed an ohmic armature resistance consuming energy. This is not true, however, for the reason that an inductance would introduce a difference of phase between the armature current and field, thereby for a given torque involving a greater flow of armature current, which would balance any saving anticipated. In the case of both motors the armature current with constant torque is constant at all speeds, and as the impressed e. m. f. is also constant, the energy expended by the motors is the same at normal and reduced speed. It therefore follows that the portion of energy which cannot be employed in useful work at the lower speed must in some manner be dissipated—that is, in the case of motors, wasted.

METHODS OF MEASURING INSTANTANEOUS VALUES OF ALTERNATING-CURRENT CURVES.

In the design and use of alternating-current apparatus, a knowledge of the wave form of pressure, flux and current is of considerable interest and importance. In transformers the hysteretic loss of energy depends to some extent upon the wave shape; with generators the resonant effect produced on long transmission lines is influenced by the wave shape; with motors the torque and efficiency depend to some extent on the wave shape. The ordinary way of determining the wave shape of pressure is by means of an instantaneous contact maker mechanically driven by the shaft of the alternator, in such a manner that the contact with the measuring instrument is effected at cyclic intervals and the phase of the contact can be advanced by successive small steps through the complete cycle. The defects of the method are that the breadth of the contact must be appreciable in order to make the contact definite, and unless a very large contact disc is employed this necessary contact breadth will represent a relative large arc in which all ripples will necessarily be lost or omitted. Sometimes this contact is made by means of a light brush resting upon the insulating periphery of a disc in which a metal contact about 1-16-inch thick is inserted. At other times the contact is made by a thin jet of salt water through which a traveling wire is carried with the alternator shaft. In all cases it is difficult to ensure the permanence and sharpness of the contact. After the curve of pressure has been determined in this way, the curve of magnetic flux whose time rate is equal to the pressure has to be found by a process of integration. If the alternating current is required it is obtained by sending the current through a non-inductive resistance and measuring the instantaneous values of the drop of pressure at the terminals of this resistance in the same manner as the alternator pressure itself.

Another means of measuring the current and pressure is with the oscillograph. Here the curves of pressure and current are photographed and recorded. The method is capable of giving excellent results but requires special apparatus and experimental skill. In this case, too, the flux curve has to be computed from the pressure curve by a process of integration. Another method was described in a paper read by Mr. Townsend before the American Institute of Electrical Engineers last week, which is interesting because it is capable of supplying the flux curve immediately from the observations without any intermediate computation. The contact-maker consists of a disc whose periphery makes and breaks contact during alternate semi-cycles. To trace the flux wave the contact disc is connected in circuit with the pressure under test through a sufficiently high non-inductive resistance and a Wheatstone voltmeter. The indication of the latter as the brush contact-maker is steadily advanced through an arc corresponding to a semi-cycle give the successive ordinates of the flux linkage. The curve so traced was marked and described as the $\mathfrak{B}$ curve in the paper, but this must have been an oversight. In the case of an alternator pressure the successive ordinates of the curve corresponding to successive indications of the voltmeter show the total number of flux linkages with the alternator armature or the total armature flux multiplied by the number of armature turns at the instant under consideration; namely, when the contact begins. If we divide this total flux linkage by the total area of the armature loops we obtain the mean induction density of the flux threading the armature coils at that instant, but this induction density may vary considerably in different parts of the armature. Similarly when the pressure under test is supplied by a transformer the successive ordinates of the curve obtained from the voltmeter represent the total flux linkages in the secondary coil at the instant when the contact commences, and this divided by the total area of the secondary loops gives the mean flux density or induction density in the secondary at that instant, although the induction density may vary appreciably in different parts of the core. The curve should therefore be considered as a flux linkage curve.

Mr. Townsend's ingenious method depends upon the mathematical fact that if a quantity varying cyclically with time be integrated in time during any half-cycle, the integral will be the difference between the initial and final values of that quantity of which the quantity integrated is the first differential with respect to time. Consequently the integral of the e. m. f. through any half-cycle as measured by the quantity of electricity sent through a measuring instrument during that time represents the difference between the initial and final values of the flux linkages during that semi-cycle, seeing that the e. m. f. is the first derived function of the flux linkages with respect to time. If the e. m. f. be symmetrical with respect to positive and negative waves, the indications of the voltmeter will represent the flux linkage at the instant of making contact, and if the e. m. f. should be dissymmetrical with respect to positive and negative waves, by some dissymmetry in the construction of the machine, then the indications would represent the mean flux linkage at the instants of making contact in positive and negative alternations.

In order to measure pressure, a quantity has to be obtained depending upon the first derived function of the pressure, and this is the pressure in the secondary coil of the open-circuit transformer supplied by a primary current proportional to the pressure to be measured. The second pressure is allowed to send currents through the contact-maker and voltmeter as before, and the indications of the instrument then give a curve of the primary pressure. The advantage of the apparatus lies in the fact that the contact maker rests upon its contact during a semi-cycle, and that the angular breadth of the contact is unable to obliterate the ripples in the e. m. f. to be measured. The method virtually consists, therefore, in the abandonment of the instantaneous contact-maker in favor of the semi-cyclical contact-maker, and instead of getting indications corresponding to instantaneous values of the quantity sought, a quantity is first produced which depends upon the time rate of change of the quantity sought, and this derived or time-rate quantity is allowed to act through the semi-cyclical contact-maker upon an instrument which automatically integrates. The indications or integrations of the instrument then represent the values of the desired quantity. The plan is certainly very interesting and ought to prove valuable in various ways.

Death of Prof. David E. Hughes, F. R. S.

PROF. DAVID E. HUGHES, F. R. S.

A cable despatch from London announces the death of Prof. David E. Hughes, F. R. S., at the age of 67. He was of Welsh descent, and was born in London in 1831. When seven years old, his father brought him to America, settling as a planter in Virginia, where the boy grew up and developed a great gift for music. At the early age of 19, Mr. Hughes was appointed to the professorship of music in the College of Bardstown, Kentucky, and soon after, having devoted his leisure to science, he was also installed in the chair of natural philosophy.

About this time, the period of rapid telegraphic development, Prof. Hughes became deeply interested in the nascent art, and began to develop his printing telegraph, and in 1855 his first patent on it in this country was taken out. It soon went into practical use in the hands of such men as Peter Cooper and Cyrus Field, and was rapidly improved, especially by the late G. M. Phelps, Sr., passing ultimately into the control of the newly formed Western Union Telegraph Company.

Prof. Hughes then went to Enrope, visiting, in 1860, France, where his type-printing system was adopted by the Government Telegraphs, and where he was made a Chevalier of the Legion of Honor. His next triumph was in Italy, where the apparatus was adopted on the report of a commission after a trial of six months, and Prof. Hughes was also decorated with the Order of St. Maurice and St. Lazare. In 1863 the system was taken up in England, and in 1865 it was adopted in Russia, where its inventor was made a Commander of the Order of St. Anne. In the same year the Hughes system was introduced on Prussian lines, and in 1867 in Austria, where he received the Order of the Iron Crown, to which the Sultan of Turkey added the Grand Cross of the Medjidie. At the Paris Exposition of 1867 he was awarded a grand hors ligne gold medal. The year 1868 witnessed the adoption of the Hughes system in Holland; 1869 in Bavaria and Wurtemburg, where he received the Order of St. Michael; 1870, in Switzerland, and 1875 in Spain, where he was made a Commander of the Order of Carlos 3d. Meantime the system had come into general use in England.

Prof. Hughes again distinguished himself by his beautiful original work in connection with the microphone and the induction balance, his independent researches on the microphone being instrumental in causing his election as a Fellow of the Royal Society. In 1881 he represented England as a commissioner at the Paris Electrical Exhibition, was elected one of the presidents of the Electrical Congress and was made a Commander of the Legion of Honor. In 1885 he was awarded the royal medal of the Royal Society, and in 1896 the Society of Arts awarded him the Albert Medal. In 1886 he was elected president of the body now known as the Institution of Electrical Engineers; in 1889 he became a manager of the Royal Institution, and in 1891 a vice-president. For many years past he has been a conspicuous figure in the social and scientific circles of London, and was a most charming acquaintance and friend, having with his wife a very cordial welcome in particular for Americans. It is said that his income from his inventions averaged about $200,000 a year, and that he has left $1,600,000 from his fortune to be divided among four of the London hospitals.

The Right to Lay a Philippine Cable.

Louis Marshall, of New York, appeared last week before the United States Senate Committee on Commerce in behalf of the Eastern Extension & Australasian Telegraph Company, the British Company which now operates the cable connections with the Philippines, and stated that he was present to submit a "caveat," or notice, of prior rights. He explained the concessions held by this company from Spain, some of them extending until 1940, and one of them granted in 1898 giving exclusive landing rights in the Spanish Pacific islands until 1918. Mr. Marshall said the company maintained that these grants by Spain were binding on the United States, as this government had succeeded to Spain's sovereignty and had put herself in Spain's shoes.

Mr. Corliss asked if it was claimed the United States could not lay a cable to Manila.

Mr. Marshall said it was held this could not be done without extinguishing the existing rights in some regular way. He submitted a brief on this point, and will be heard further.

Captain Squier, Acting Chief Signal Officer, stated that owing to the assertion of exclusive rights, the War Department had secured copies of the original concessions under which this British company was operating. He said these controverted the claims of exclusive rights. They were being translated, and would soon be submitted to Congress.

The Pacific cable question was also taken up by the House Committee, and General Wager Swayne, of New York, spoke in favor of private construction and operation of the cable line as against government ownership.

Meeting of the American Institute of Electrical Engineers.

The 139th meeting of the Institute was held on Wednesday evening, Jan. 24, President Kennelly in the chair. A paper was presented by Mr. Fitzhugh Townsend, of New York City, on "A New Method of Tracing Alternating Current Curves." The discussion was opened by Dr. Sheldon and continued by Mr. C. P. Steinmetz and Dr. M. I. Pupin. A paper was also read by Mr. Chas. P. Steinmetz, of Schenectady, entitled "Notes on Single-Phase Induction Motors and the Self-Starting Condenser Motor." Messrs. Pupin, Bradley and others took part in the discussion.

At the meeting of council held in the afternoon the president announced the death of James Hamblet, formerly a vice-president and manager of the Institute; also of Samuel Dana Greene, who at the date of his decease was serving the first year of his term as manager. The president stated that he had appointed committees to prepare suitable resolutions and memorials to be printed in the Transactions.

It was voted to hold the next general meeting of the Institute in Philadelphia, which should adjourn to meet in Paris on Aug. 16. The date of meeting in Philadelphia was not fixed. Over 60 members have promised to attend the European meeting.

The following associate members were elected: Bernhard A. Behrend, Erie, Pa. Edmund Walter Beveridge, assistant engineer, the G. I. P. Railway Company, India; Sirud Khandish District, Bombay, India. John Denham, electrician, Cape Government, Cape Town, South Africa. Paul H. Evans, chief engineer, Mexican General Electric Company, Apartado 403, Mexico City. George Greenwood, electrical engineer and superintendent, Jalapa Railway & Power Company, Jalapa, V. C., Mexico. Gwyllym R. Holmes, Holmes, Rose Electric Company, 2842 Parkwood Avenue, Baltimore, Md. J. E. Hindon Hyde, 120 Broadway; residence, 48 West Eleventh Street, New York City. Benjamin Magnus, electrical engineering student, Columbia University, residence, 22 East 111th Street, New York City. Harry B. Niles, electrical engineer, Ferro Carrillos del Distrito, American Club, Mexico City. Alois J. J. Pfeiffer, engineer, Thomson-Houston Company, 5 Piazza Castello Milano, Italy. Charles Oscar Poole, general superintendent electrical department, San Francisco Gas & Electric Company, 229 Stevenson Street; residence, 452 Bryant Street, San Francisco, Cal. Wilfred Van Nest Powelson, government inspector, electrical appliances, General Electric Company, Schenectady, N. Y.; lieutenant United States Navy. Frederick Alexander Saylor, chief electrician, U. S. S. Chicago; residence, Reading, Pa. R. L. Selden, Jr., Deep River, Conn. J. Harry Shearer, electrical engineer, National Electric Light Company, Apartado 639, Mexico City, Mexico. Robert R. Shephard, erecting engineer, Mexican General Electric Company, Apartado 403, Mexico City, Mexico. Milton T. Thompson, constructing engineer, Mexican General Electric Company, Apartado 403, Mexico City, Mexico. Max W. Zabel, draughtsman and student of patent law with Messrs. Brown & Cragg, 1450 Monadnock Building; residence, 454 North Avenue, Chicago, Ill.

The following associate members were transferred to full membership: Walter Douglas Young, electrical engineer, B. & O. R. R., Baltimore, Md. Robert T. E. Lozier, electrical engineer, member of firm of Bullock Electric Company, St. Paul Building, New York City. H. A. Storrs, assistant engineer, United States Engineer's Office, New London, Conn.

Plant of London Metropolitan Electric Supply Company.

TWO years ago a contract was awarded to the English Westinghouse Company for supplying three two-phase alternators of 2500-hp each for the new power house of the Metropolitan Electric Supply Company, London. This size was then considered an innovation in electric lighting practice, exceeding any constructed up to that time, excepting the 5000-hp generators at Niagara Falls. Since then, it may be remarked, improvements in machinery have enabled far larger generators to be constructed. For instance, the units now being built for the Third Avenue Railway Company, New York, consist of sixteen generators of 7000-hp maximum capacity each, with steam engines of corresponding capacity.

STEAM ENGINES.

The three steam engines of 2500-hp each, one of which is shown in Fig. 1 and which were built at East Pittsburg, Pa., by the Westinghouse Machine Company, are of the enclosed vertical compound marine type, with the crank shaft extended at one end to carry the revolving element of the alternator directly upon it. Each of these engines is capable of developing the full rated power of the alternator at 133 r. p. m., with 100 pounds steam pressure. The economical load is secured at 140 pounds steam pressure and 120 r. p. m. As the three alternators are to run in parallel, the angular velocity of the engines is made sufficiently uniform to insure successful parallel running.

The cylinders are 36 inches and 55 inches in diameter respectively; the stroke is 36 inches. The cylinders are made of close-grain cast-iron, and as the engines are of the vertical type, the danger of cutting the cylinder castings is reduced to a minimum. Steam is distributed to the high pressure cylinder by a piston valve, and two piston valves serve the low pressure cylinders. The cylinder covers, pistons, etc., are provided with improved means to render their removal easy. The cylinders and steam chests are fitted with automatic water-relief valves and drains, which keep the engines free from condensation. The drain valves are operated from the working platform by levers. Forged steel is used for the crank shafts, which are 14 inches in diameter at the bearings and 20 inches at the armature hub. They are hollow throughout their entire length. The alternator, mounted directly on the engine shaft, serves as a flywheel. The engines are fitted with permanent indicating outfits, which are accessible from the main platform, together with an elaborate system of lubrication, a system for cooling the bearings, and provisions for varying the speed while running. All these adjuncts assist in enabling the engines to be run for long periods without stopping. The main bearings, which are cooled by water, are of the quarter-box type, and can be moved in any direction by means of suitable wedges. The main bearings are 14 inches in diameter and 42 inches long. Provision is made to allow the covers to be raised to facilitate inspection.

Sight feed lubricators are used, the oil being carried through brass tubes from the sight feed oilers and manifolds on the cylinders. These are connected to a reservoir on top of the cylinders, which is supplied by a force pump, taking oil from filters. A single inertia governor, which actuates the high pressure valves, controls the engine. The low pressure valves are operated by fixed eccentrics. The governor is keyed to the main shaft and allows an adjustment of 10 per cent. while the engines are running. This permits the speed of the machines to be varied to facilitate operation in parallel. The maximum variation of the governor at any speed within the rated limits is 1 per cent.

GENERATORS.

The three Westinghouse generators shown in Fig. 2 are of 1500-kw

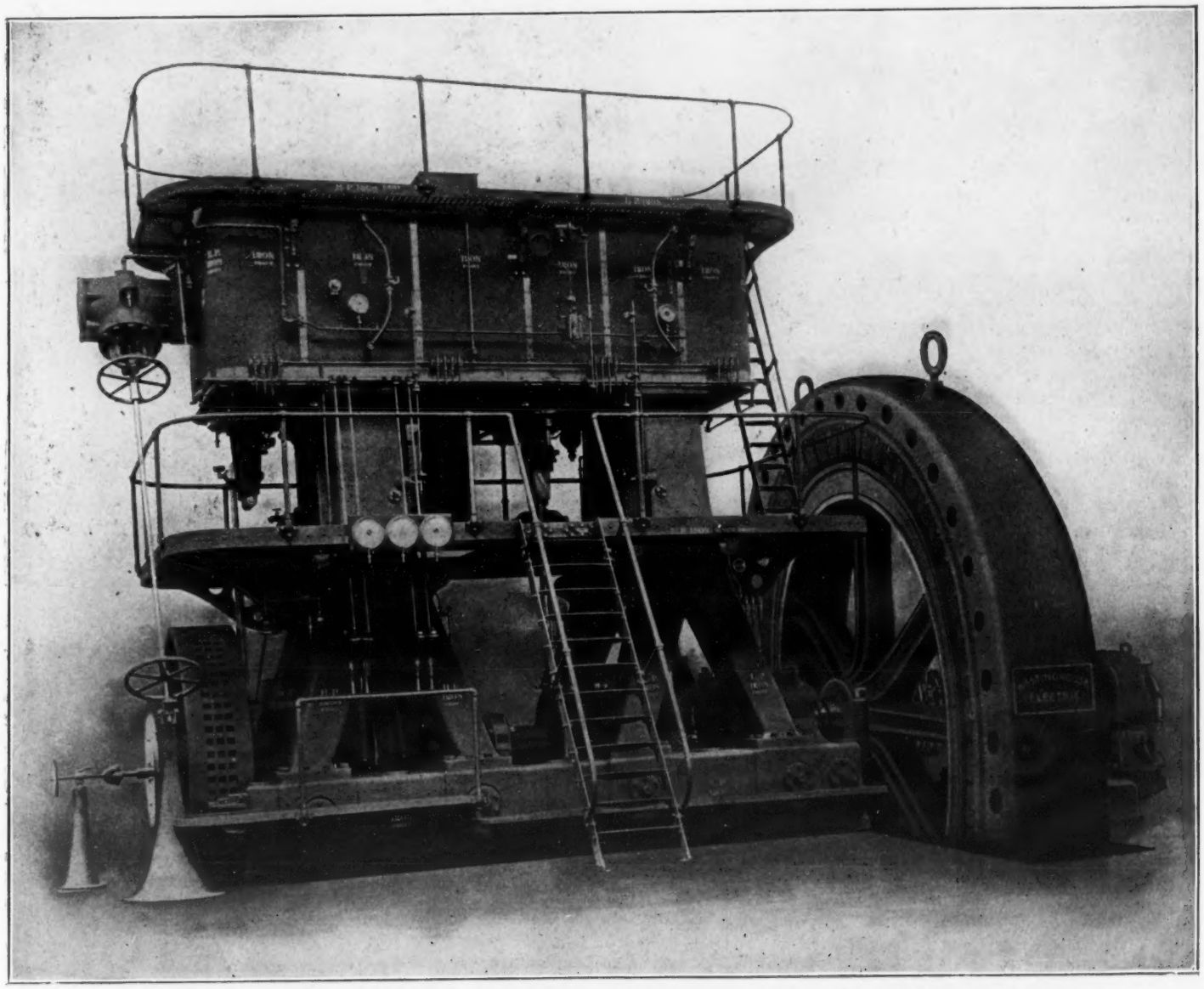


FIG. 1.—VERTICAL COMPOUND 2500-HP STEAM ENGINE, METROPOLITAN ELECTRIC SUPPLY COMPANY, LONDON.

capacity; they are of the two-phase type, generate at 500 volts, and are direct-connected to the steam engines. The field consists of a cast-iron frame with 62 pole-pieces, which are built up of laminated soft steel. The frame is made in halves secured together by bolts. This arrangement allows the halves to be moved back so as to clear the revolving armature. A view of half a field casting is shown in Fig. 3, together with an armature spider, which give an excellent idea of the magnitude of this massive machine, with the 62-pole pieces cast into the heavy mass of metal, at accurately spaced intervals.

The field coils are wound with copper strip, bent on edge and thoroughly insulated before bending. The armature spider is constructed of cast-iron in halves, with massive rims. The arms of the spider are cast with splitting plates between them to insure freedom from strain in cooling. They are secured in position on the crank shaft by two heavy mild steel rings, shrunk around the bosses at the base of the arms. Each rim is secured by two bolts, and by a shrinkage ring at each joint. The cast-iron arms are supplemented by steel bolts screwed into the boss and secured to the rim by heads, flush with the external surface. The armature conductors are embedded in slots in the periphery of the armature ring.

Steel punchings are mounted on the periphery of the spider, the former being suitably notched to receive the armature conductors, which are large copper bars of rectangular section, heavily insulated and imbedded in the slots. The laminæ on the armature are assembled so as to provide numerous ventilating ducts to enable ample passage of air through the cores and for keeping the temperature of the armature at a low point. The armature is wound with a distributed closed-circuit winding, and the four collector leads draw their current from four equi-distant points on the winding.

Each alternator is capable of delivering at the armature terminals the total output of 3000 amperes at 500 volts, or 2727 amperes at 550 volts, divided into two equal two-phase circuits, without the temperature of any part rising more than 33° C. above the surrounding atmosphere. An overload of 25 per cent. can be carried, with the temperature not exceeding 45° C. Three compound multipolar exciters have been provided, which are direct-connected to the generator shaft and wound for an exciting current of 100 volts.

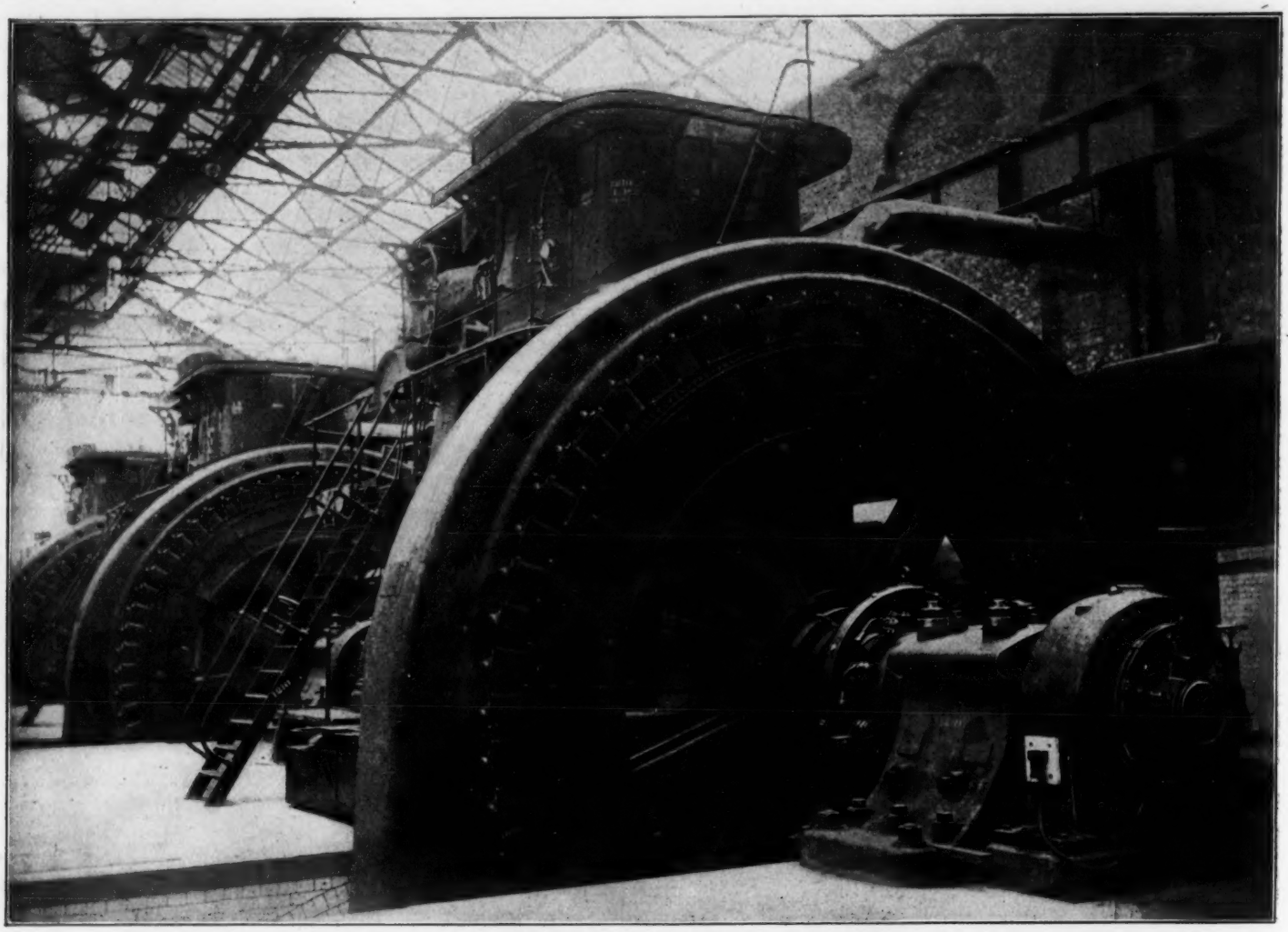


FIG. 2.—THREE 1500-KW TWO-PHASE GENERATORS, METROPOLITAN ELECTRIC SUPPLY COMPANY, LONDON.

SWITCHBOARD.

This board controls the three 1500-kw, 500-volt, 60 p. p. s. two-phase generators running in multiple, and the three 25-kw 125-volt compound wound direct-current multipolar exciters. The switchboard also controls a storage battery used as an alternate source of excitation. The board comprises three panels of white Italian marble similar in equipment; a desmription of a single panel will therefore suffice for the whole board.

Fig. 4 shows the front of the board, and Fig. 5 the rear. Among the instruments are the following:

A 3-pole 1500-ampere automatic brush-type circuit breaker. Two 2000-ampere main ammeters, provided with a 5-ampere coil and operated from the 5-ampere secondary of a 2000 5-ampere series transformer. A 450-ampere direct-current field ammeter. Two Niagara type indicating wattmeters. The series coils of these meters are run in series with the coils of the ammeters noted above, thus necessitating only two series transformers for each panel equipment.

One 300-ampere double-throw field switch, which is of the quick-break washer type and provided with a special attachment for discharging the field of the alternating current generator through a shunt resistance mounted on a bracket at the rear near the top of the switchboard. The switch is made double throw, so that the generator field may be connected to either source of excitation, the exciter or storage battery. The shunt resistance is connected so as to discharge the field when excited from either source of excitation. This discharging the field through a shunt resistance prevents the possibility of a breakdown in the field insulation, whereas it is subjected to severe strain when the field is opened without this provision. On the lower marble slab are mounted the combination alternating and direct current rheostat hand wheels for the controlling rheostats in the generator fields and exciter fields.

The main alternating-current bus-bars are built up of 3" x ⅞" copper strap, and are mounted on insulated bus-bar brackets at about the centre of the rear of the switchboard.

The storage battery exciter bus-bars are run at the rear of the board immediately above the rheostat face plates. To these bars

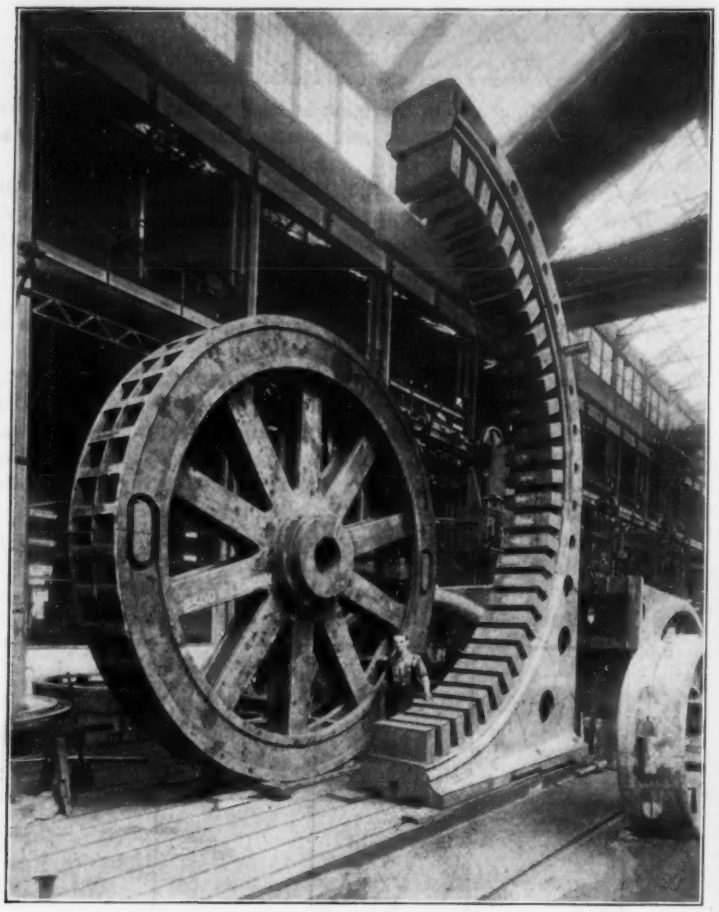


FIG. 3.—ARMATURE SPIDER AND ONE-HALF OF FIELD CASTING OF 1500-KW TWO-PHASE GENERATOR.

the storage battery leads are connected, and from them the storage battery exciting current is distributed to the field circuit.

In addition to the apparatus specified above for each panel three voltmeters are mounted on a swinging arm, as follows:

One alternating machine voltmeter, on which, by means of 6-point voltmeter plug switches on each generator panel, the voltage across either phase of any machine can be read. One alternating-current bus-bar voltmeter on which, by means of a 5-point ground detector plug receptacle on "Panel A," the voltage across either phase of the bus-bars may be read. One direct voltmeter on which, by means of 4-point voltmeter plug switches, the exciting voltage on the field of any of the alternating-current generators may be read.

Iron Works Operated by Niagara Electric Power.

BY FRANK C. PERKINS.

ANOTHER application of Niagara electric power has been just started in Buffalo, N. Y., with great success. The steel and malleable iron plant of Pratt & Letchworth, at Black Rock, now operating entirely from current generated at

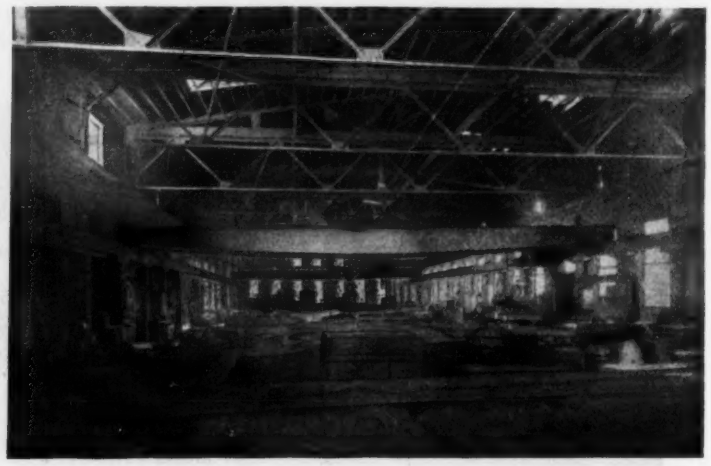
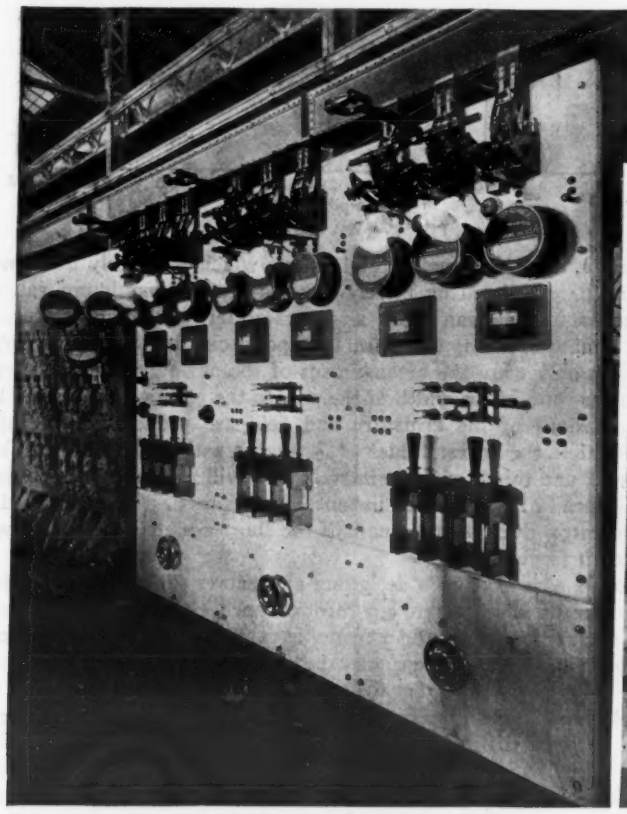


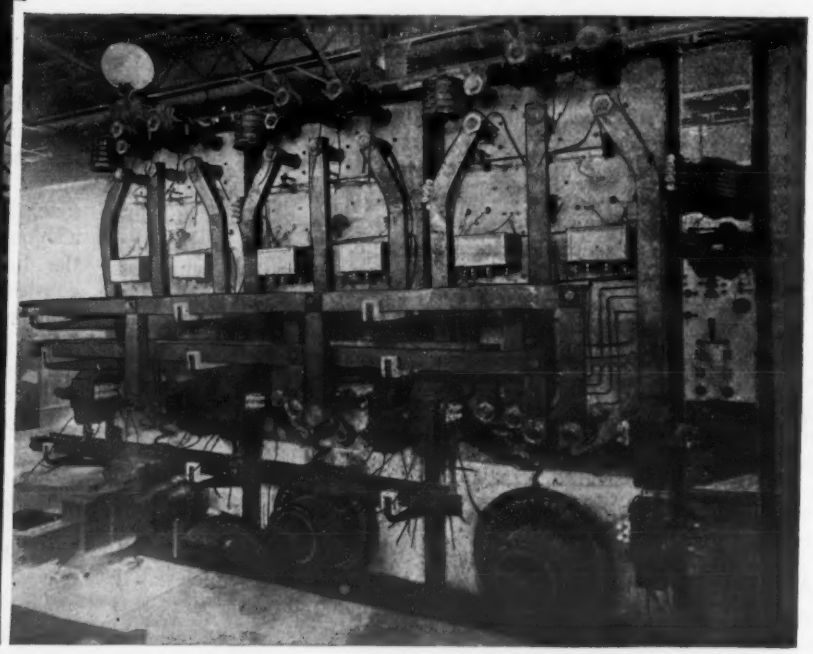
FIG. I.—ELECTRIC CRANE.

Niagara Falls, covers 12 acres under roof, besides 11 acres of yard space.

Two huge electric cranes are of great interest as they carry the molten metal to the various moulds showing the simplicity and great flexibility of electricity for purposes of this kind. These motors are direct current 220-volt motors and receive their current from the rotary transformers mentioned below.

Three-phase currents at 11,000 volts are received from the Falls at the Cataract & Conduit Company's substation and by static





FIGS. 4 AND 5.—FRONT AND REAR VIEWS OF SWITCHBOARD, METROPOLITAN SUPPLY COMPANY, LONDON.

transformers reduced in pressure to 2200 volts, the frequency being 25 cycles. The conductors entering the Pratt & Letchworth plant conduct the 2200-volt three-phase currents through oil enclosed switches at the switchboard to three static step-down transformers, reducing the e. m. f. again to 170 volts. A G. E. rotary converter is employed, both for supplying direct current for the main shafting and also for supplying direct current to the various motors in the different shops.

This rotary transformer, shown in the illustration, receives the alternating currents at 110 volts at a frequency of 25 cycles, operating the converter as a motor at a speed of about 750 revolutions per minute. About 100-hp is taken off from the pulley for driving the main shafting and taking the place of a large engine, now held in reserve in case of accident. From the direct-current commutator of the converter a current of 250 volts is supplied to the shop motors to the extent of about 800 amperes. It will thus be seen that this machine takes the place of not only the main steam engine which previously operated the plant but also the electric generators which furnished the current for lighting the shops and operating the direct-current motors. The machine is of 250-kw capacity and of the latest type of construction. Pratt & Letchworth are prepared to increase their nower plant above 300-hp when the extra power becomes necessary.

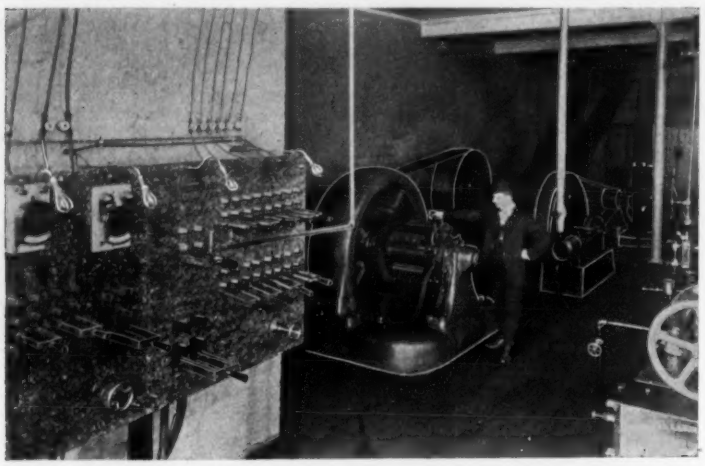


FIG. 2.—SWITCHBOARD AND ROTARY CONVERTER, NIAGARA FALLS.

Invited guests witnessed the starting of the Niagara motor, promptly at noon and when Superintendent J. C. Bradley threw the switches the converter and various motors about the shops responded without trouble to the great interest of those gathered in the engine room. After inspecting the remainder of the works the guests proceeded to the banquet room where a feast was waiting. Mr. O. P. Letcher, president of the company, introduced the various speakers, who responded with the usual compliments on such occasions.

So far the consumers of electric power in Buffalo are mostly those who use it in quantities ranging from 100-hp to 3000-hp. The smaller consumers are yet to be reached. That the power is all that is claimed is proved by the fact that its use is constantly growing. If it is not all that it is claimed for it, we would not find manufacturers throwing out effective steam plants and installing in their places the electric equipment. The latter take up much less space than do boilers and engines, are run with less danger and with less expense. The economy of space is intelligible to the sight. The economy of operation is not so easy to demonstrate because few power users know what their power actually costs them. Expert tests show that they are getting perhaps 50 per cent. of their power plant when they supposed they were getting the full power, but it is often difficult to make them believe it.

Three-Day Atlantic Trip.

A lecture recently was given at the Royal Institution by Mr. C. A. Parsons, builder of the turbine destroyer Viper, which lately reached a speed of 45 miles an hour. It is generally considered that the turbine system is unsuitable to large vessels, but he declared he was prepared to build an unarmored cruiser capable of making 48 knots. Atlantic liners which would cross in three days, he declared, might be built with turbine engines.

The Factors Which Determine the Design of Mono-Phase and Polyphase Generators—III.—(*Concluded.*)

BY B. A. BEHREND.

THE SHORT-CIRCUIT CHARACTERISTIC.

In the preceding article the manner of determining the dynamic characteristic from the static and short-circuit characteristics has been set forth.

If n is the number of conductors per pole and phase, I the current flowing through each conductor, and x the number of ampere-turns in the field for one closed magnetic circuit, then we have for a short-circuited armature the equation:

$$\lambda n I = x \ldots\ldots \ldots\ldots\ldots\ldots (2)$$

In this equation λ is a coefficient varying with the dimensions of the armature and the field.

The theoretical determination of λ is extraordinarily difficult; indeed, it might be doubted whether any weight should be attached to such a calculation which must needs contain a great number of other coefficients, about the value of which we are equally as uncertain as we are about λ itself. It has been assumed as though it were a matter of fact that λ could easily be calculated from the ampere-turns of field and armature. If there were no primary and secondary leakage this could, indeed, easily be done. The calculation yields a value for λ according to the assumptions made, varying between 2.2 and 2.8 for three-phase currents. As there are a great many people who believe that λ, even if we neglected leakage, which is entirely unallowable, can be calculated by merely figuring out the maximum value, as some do, or the mean value, as others prefer, of the ampere-turns on the armature, it may be desirable to point out that λ depends very much, not only upon the arrangement of the armature winding, but also on the ratio of the width of the pole to the pitch of the poles. If the dimensions of the armature and field are properly taken into consideration, the lowest values of λ, that is without leakage, can be calculated, and this is of some interest as it will increase our surprise when, instead of $\lambda = 2.7$, for instance, λ rises to 5.4; in other words, our generator gives us only one-half the short-circuit current that we expected it to give.

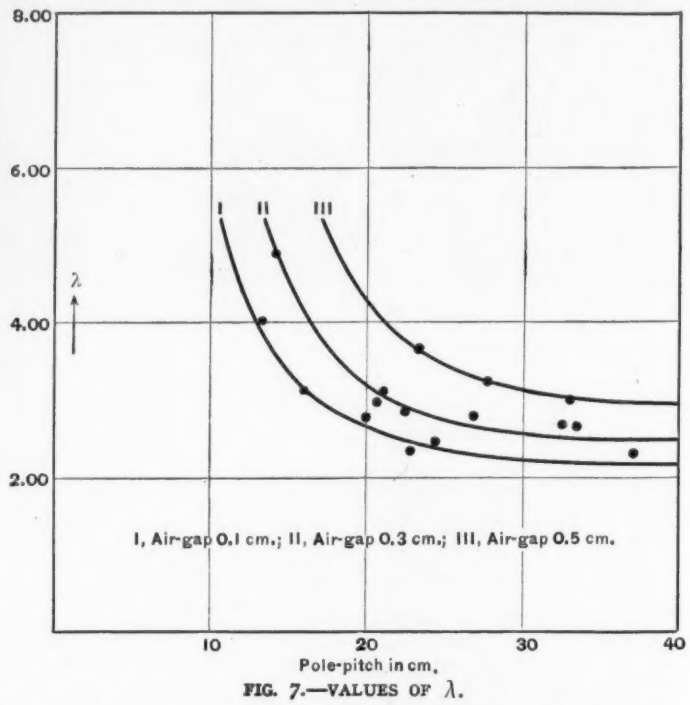


FIG. 7.—VALUES OF λ.

All of us who have been designing alternators for high frequencies or low speeds have had to go through such experiences. A great many speculations and wild guesses have been advanced to account for these apparent discrepancies between theory and observation. About three years ago I began to suspect that the *absolute* value of the pole-pitch might offer a clue to the explanation of these discrepancies. Almost all of the machines that I measured were of the inductor type, and in them the influence of the air-gap on λ greatly complicates the problem. But with the accumulation of experimental material, the problem grew more and more perspicuous, and the influence of the air-gap on λ could be separated from that of the pole-pitch.

After the preceding it is hardly necessary to speak of the importance of λ as determining the design of the alternator. The output of single and polyphase generators working on power circuits, and, to a certain extent also, the output of generators working on light, is determined by the maximum drop permissible. This drop is directly proportional to the value of λ; hence I am justified in saying that λ is the factor on which hangs, in large measure, the success of the design.

The curves in Fig. 7 show the value of λ as a function of the pole-pitch and of the air-gap in three-phase inductor generators. The ordinates of the curves represent the values of λ, the abscissæ the pole-pitch. Curve I. is drawn for an air-gap $\triangle = 0.1$ cm.; Curve II. for $\triangle = 0.3$ cm., Curve III. for $\triangle = 0.5$ cm. The magnetic and electric arrangement of the machines measured is shown by Fig. 8. The pitch of the armature coils was equal to the pole-pitch; the armature coils were lying in slots, one per pole and phase. The width of the pole-horns was equal to, or slightly smaller than, the pole-pitch.

The most striking feature of these curves is their tendency to rise rapidly if the pole-pitch is smaller than 25 cm. For small pole-pitches the air-gap is of intrinsic importance; with increasing pole-pitch the curves tend to converge. Let us try to account for these observations. If we diminish the pole-pitch, the magnetic flux emitted by each pole is diminished in the same ratio as the pole-pitch. If we assume that the magnetic resistance of the main field remains constant, then the ratio, leakage field : main field, has increased in the same proportion as the pole-pitch has been diminished, since the magnetic resistance of the leakage field decreases in proportion to the pole-pitch.

This holds good of the leakage of the field as well as of that of the armature, as can easily be seen. A glance at Fig. 9 shows that the leakage lines of the armature run in loops around the slots. The leakage remains therefore constant whether we change the pitch of the coil or not. But the field which produces the e. m. f. in the coils varies in proportion to the pitch of the coil, hence the ratio, armature leakage : main field, varies inversely as the main field; that is, as the width of the pole, or as the pitch of the poles, since the ratio width of pole : pitch of pole, may be assumed as constant.

By means of the curves of Fig. 7 it is easy to find the value of λ for any pole-pitch and air-gap for three-phase current generators of the inductor type. My experience with generators with alternating poles is not sufficient to enable me to plot their λ curves for pole-pitches smaller than 20 cm. For pole-pitches larger than 20 cm. the values of λ agree well with Curves I. and II. For these large pole-pitches λ is practically independent of the air-gap; for small pole-pitches λ increases with increasing air-gap.

FREQUENCY.

We are now in the position to study the bearing of the frequency on the dimensions of the generator. The question which the practical designer is called upon to answer is, whether a generator wound for, say, 50 ~, can be more advantageously used for a higher or lower frequency. This question can immediately be answered with the help of our curves. A glance at them teaches us that the problem cannot be solved in a general way, but that each case has to be treated individually. As for the same voltage and the same magnetic frame the total number of conductors in the armature is the same for all frequencies—increased field leakage for small pole-pitches being neglected—the number of conductors per pole and phase are inversely proportional to the frequency. Hence, the short-circuit current for the same excitation x in the field can be given by the formula:

$$I' = I'' \times \frac{\lambda''}{\lambda'} \times \frac{\sim'}{\sim''} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

In this equation I' and I'' denote the short-circuit current, λ' and λ'' the values of λ pertaining respectively to the frequencies $\sim'$ and $\sim''$.

If a higher frequency is to be advantageous the quotient $\frac{\lambda'}{\lambda''}$ must be larger than the quotient $\frac{\sim'}{\sim''}$. An example will bring this into clearer light. The pole-pitch be 25 cm. for 50 ~. For eighty periods it would be 15.6 cm. The value of λ for 25 cm. pole-pitch is for an air-gap of 0.3 cm. equal to 2.75, while it is for a pole-pitch of 15.6 cm. equal to 4.15. Hence the short-circuit current for 80 ~ is equal to

$$I_{80} = I_{50} \times \frac{2.75}{4.15} \times \frac{80}{50} = 1.06\, I_{50}$$

In other words, the short-circuit current I_{80} is practically equal to the short-circuit current I_{50}. For the same drop the output of the 80 ~ machine is therefore equal to the output of the 50 ~ machine with, practically, the same amount of iron and copper. Of course, it is obvious that the 80 ~ machine is more expensive than the 50 ~ machine, on account of the greater number of slots and poles, needing more insulating material and involving more labor.

For 40 ~ we should have

$$I_{40} = I_{50} \times \frac{2.75}{2.57} \times \frac{40}{50} = 0.86\, I_{50}$$

Hence, for 40 ~ the machine would give a smaller output than for 50 ~.

For 60 periods we have

$$I_{60} = I_{50} \times \frac{2.75}{3.00} \times \frac{60}{50} = 1.1\, I_{50}$$

In other words, the generator gives 10 per cent. more power for 60 ~ than for 50 ~. Table IV. contains the output of the generator for different frequencies.

TABLE IV.

~	Pole-pitch.	λ	Output.
30	41.6	2.50	0.66
40	31.2	2.58	0.86
50	25	2.75	1.00
60	20.8	3.04	1.09
70	17.8	3.52	1.095
80	15.6	4.14	1.06
90	13.9	4.80	1.03
95	13.2	5.54	0.95
100	12.5	8.50	0.65

Fig. 10 represents these relations graphically. The curve illustrates that between 45 ~ and 90 ~ the output of the generator is practically constant. If the increased field leakage at higher frequencies were taken into account, the curve would have the form of the broken line curve, and the output would, at no frequency, be greater than at 50 ~. If the frequency is increased above 80 ~, the machine is worked at a part of the curve where the slope is so steep that we can no more rely on any predetermination, as a very slight inaccuracy of the λ curve reduces the output tremendously. It would, therefore, not be advisable to work with a frequency higher than 80 ~. This, of course holds good only in the case under consideration.

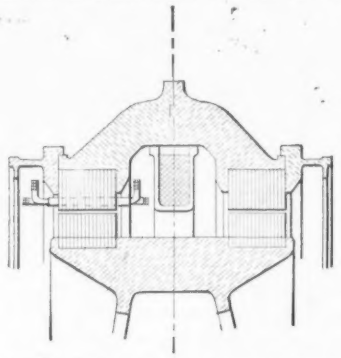


FIG. 8.—DETAILS OF MACHINE FROM WHICH VALUES OF λ WERE DERIVED.

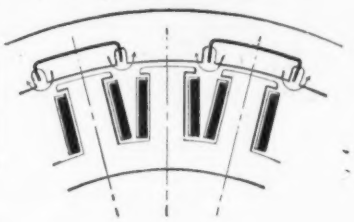


FIG. 9.—ILLUSTRATING LEAKAGE.

The way of reasoning here followed out supposes that the pole-pitch cannot be increased at higher frequencies. This is the case when the circumferential speed limits the diameter of the field. If circumferential speed does not limit the diameter, as in slow-speed generators, mechanical and economical conditions restrict the diameter. The way chosen for the determination of the best frequency is therefore applicable in general.

In our calculation we have tacitly assumed that the induction in the air-gap is the same for all frequencies This assumption involves a far greater loss through eddy currents and hysteresis with higher than with lower frequencies. For induction motors a low frequency of 40 or 50 is always desirable, as in them a large pole-pitch is of even greater importance than in alternators.

How the curves of Fig. 7 can be used for the calculation of three-phase current generators, will now be clear without further comment. The total sectional area of all the wires of the armature coils for which can be found room in the generator, can approximately be set proportional to the circumference of the armature. Per 1 cm. circumference of the armature we may reckon about ½

square cm. of copper in the armature coils. Having thus found the amount of copper that we can place on the armature, the diameter of which being already determined, we find the number of convolutions of the armature coils by choosing a value for the current density, a good mean value being 300 amperes per square cm. Thus the number of turns being found, we proceed to calculate by means of equation (1) the flux per pole. As the pole-pitch is known, λ can be taken from the curves of Fig. 7, the short-circuit characteristic can be drawn, and the dynamic characteristic be determined.

It is not very long ago that the coupling in parallel of alternators was constantly under discussion. I fully agree with Mr. W. M. Mordey that "there is no evidence whatever that lowering the frequency is an advantage in connection with parallel working, except in some inferior types of machines."[6] Those who failed in coupling alternators for high frequencies in parallel, failed not on account of the frequency having been too high, but because the pole-pitch in their alternators was chosen too small, on account of the high frequency. They thus mistook a coincidence for a cause, a symptom for the evil.

Two-Phase Alternators.—Take a three-phase generator, separate the three phases, and connect two phases in series. The e. m. fs. in the two phases, though unequal, are in quadrature with each other. The e. m. f. of the one phase being called E, the e. m. f. of the two

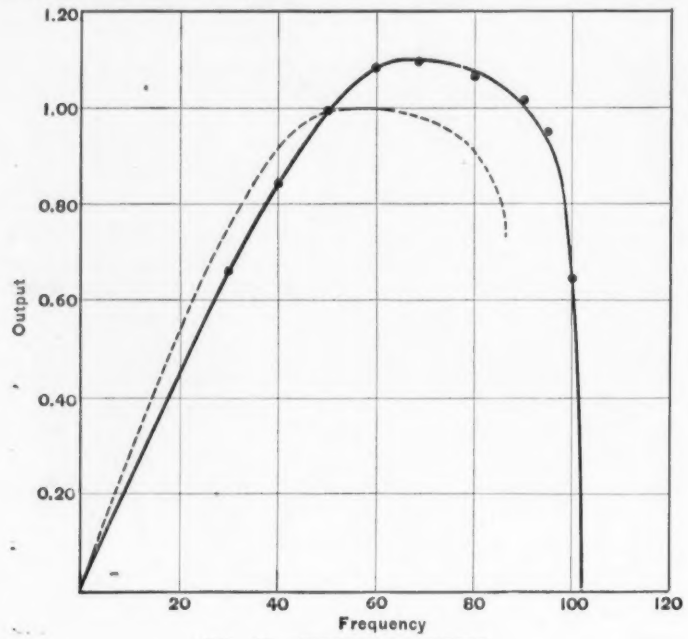


FIG. 10.—FREQUENCY CURVES.

phases connected in series is then $E\sqrt{3}$. If we short-circuit these two phases, each in itself, *the sum of the short-circuit currents is equal to the sum of the short-circuit currents in three phases when in star connection.* The only difference between the two-phase machine in our case, and an ordinary two-phase machine is that in the former one phase has one slot per pole, the other two; while in the latter the number of slots is equal in both phases. This will cause the short-circuit current to be slightly smaller in the latter case than in the former.

From the foregoing we gather that λ for two-phase currents is equal to two-thirds of λ''' for three-phase currents.

$$\lambda'' = \frac{2}{3}\cdot\lambda''' \qquad (3)$$

Single-Phase Alternators.—The value of λ' for single-phase alternators is about one-half of λ''', sometimes a little more, sometimes a little less. This shows that for equal inductive drop an alternator wound for single-phase currents gives one-half more output if wound as a three-phase current generator. But as the load of single-phase alternators consists, in general, mainly of light, the power factor of the external circuit being as a rule near unity at full load, single-phase alternators may safely be wound for the same output as three-phase current generators.

The value of λ is, of course, influenced by the number of slots per pole. The following experiment will elucidate this point. Of two generators of the same type and size one was wound as a single-phase alternator, the other as a three-phase generator. The alternator had one slot per pole; the three-phase generator one slot per pole and phase, three slots per pole. The results were the following:

1. Single-phase alternator, one slot per pole, $\lambda = 1.56$.
2. Single-phase alternator, two slots per pole, $\lambda = 1.39$.
3. Three-phase generator, three slots per pole, $\lambda = 2.90$.

The output in these cases for equal inductive drop is as follows:

1. $\dfrac{E}{1.50} = 0.64\,E.$
2. $\dfrac{\sqrt{3}\cdot E}{1.39} = 0.622\,E.$
3. $\dfrac{3\cdot E}{2.90} = 1.03\,E.$

The figures speak for themselves and need no further explanation.

We have seen that Dr. Behn-Eschenburg's method of determining the "synchronous reactance" in alternators gives results accurate enough for practical purposes. But we have also seen that the theoretical value of this method is a doubtful one. The investigator who attacks the problem of the determination of the inductive drop without foregone conclusions, will, I feel convinced, arrive at similar results as those which are set forth in this article. The problem is not yet solved, but I doubt whether it will be possible to find a way of predetermining the "synchronous reactance" which is as simple and as accurate within certain limits as the way here taken.

To give experimental corroborations of Dr. Behn-Eschenburg's method of determining the "synchronous reactance;" to dispel the doubt that naturally hangs about a deductive method as long as experimental data do not underpin it; to point to the paramount influence of the leakage, as caused by a small pole-pitch, upon the inductive drop and therefore upon the output of alternators; these are the main points to the clearing up of which I have endeavored to contribute in this article.

[6] *Journal* of the Proceedings of the Institution of Electrical Engineers, England, Part 108, Vol. XXII.

The Polyphase Induction Motor*—I

BY RALPH D. MERSHON.

To many men in electrical work the induction motor is an object of more or less mystery. Of the theory of the direct current motor they have at least the knowledge which enables them to successfully use and care for that piece of apparatus, but of the action of the induction motor they know little. Even in the case of many who have had experience in the operation of induction motors the knowledge of such a motor is limited to the fact that when in order and properly connected to its circuit it runs and carries its load. This condition of affairs is largely due to the fact that most discussions of the theory of the induction motor involve more or less of mathematics or complicated diagrams, which are not especially interesting or agreeable to many; besides such discussions rarely furnish a basis for a working theory which, above all, the practical man is after.

I shall endeavor to take up the salient points in the theory of the induction motor in a way which will involve neither mathematics nor complicated diagrams, and which will furnish the basis of a practical working theory; such a theory as is sufficiently complete for those not actually designers of this class of apparatus.

You are doubtless familiar with the experiment due to Arago which is illustrated in Fig. 1. D is a disc of copper free to revolve upon a jeweled bearing at its centre. NS is a bar magnet suspended over the disc. If now the magnet be made to revolve about its point of suspension the disc will also begin to revolve and will finally acquire a speed approaching, but not equal to that of the magnet. If instead of revolving the magnet we revolve the disc the magnet will acquire a speed approaching that of the disc.

Let us inquire into the cause of these actions. We know that if a conductor be moved across a magnetic field, or, what amounts to the same thing, if the magnetic field be moved so as to sweep across the conductor, the conductor will have generated in it an electromotive force. If the conductor form a part of a closed circuit this e. m. f. will cause a current to flow in the circuit, the strength of the current depending upon the magnitude of the e. m. f., and the resistance of the circuit. We have in Fig. 1 the magnetic field—that due to the magnet NS—and the disc which, being made of copper, is a conductor. By revolving one of the elements, either disc or magnet, we cause the conductor to cut lines of force. There is, generated in the conductor, the disc, an electromotive force, or, rather, electromotive forces, and if these

*Paper read at the convention of the Northwestern Electrical Association, Milwaukee, Wis., Jan. 18, 1900.

electromotive forces can find closed circuits in the disc currents will flow. There are in the disc an indefinite number of closed circuits, as an inspection of Fig. 2 will show. Here we are looking down upon the magnet and disc of Fig. 2, and the magnet is supposed to be rotating at a uniform speed in the same direction as the hands of a watch. At any given instant we may suppose that there exists in the disc the four elementary circuits *A1*, *A2*, *B1*, *B2*, shown in Fig. 2. These are the circuits with which we are concerned at a given instant. At the next instant we must consider four other elementary circuits, slightly displaced from those shown in Fig. 2 in the direction of the rotation of the magnet, because as the magnet rotates it changes its position with reference to the disc affecting successively different portions of the latter. The disc may, therefore, be considered as being made up of an indefinite number of overlapping circuits, four of which may be considered as active at the instant when the magnet bears the relation to them which in Fig. 2 it bears to the circuits *A1*, *A2*, *B1*, *B2*. Those portions of the circuits *A1*, *A2*, *B1*, *B2*, which are lying immediately below the magnet, are being cut by lines of force and are having, therefore, electromotive forces generated in them. These electromotive forces and the currents due to them in the elementary circuits are in the directions shown by the arrows. It should be noted, that if by any means the disc be made to rotate at the same speed as the magnet the relative position of disc and magnet will not change and there will be therefore no E. M. F. generated and no current will flow.

So much for the currents in the disc. The next question is why should the generation of these currents by the rotation of the magnet cause the disc to rotate? In order to explain this let

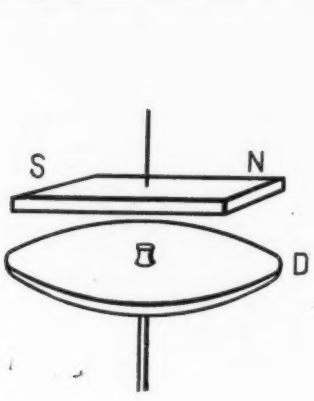


FIG. 1.

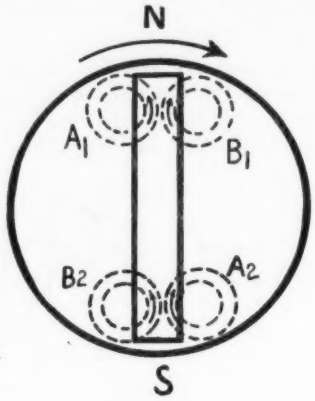


FIG. 2.

us recall Lenz's law. This law states that if the number of lines of magnetism in a coil of wire or in any closed circuit be changed, there will be generated in that circuit, while the change is taking place, a current which will have such a direction as will tend to oppose the change producing it. That is to say, if a magnet be thrust into a closed coil or if, being in the coil, it be withdrawn, a current will be generated which will oppose the motion. In the second case, where the magnet is withdrawn from the coil, the current will be in such a direction as will tend to hold the magnet in the coil, or, what amounts to the same thing, as will tend to move the coil after the magnet. In the first case, the current will tend to keep the magnet from entering the coil, or to push the coil away from the magnet. The magnet need not, however, be actually thrust into the coil. It may be merely brought up into the neighborhod of it, providing its lines of force cut the coil.

Further, it does not make any difference how or from what direction the magnet is brought up to the coil, whether from one side or whether along the axis of the coil. So long as its lines of force cut the coil every movement of the magnet will be accompanied by the generation of current which will tend to oppose its movement. In the elementary circuits shown in Fig. 2 the magnet is just leaving the circuits *A1* and *A2* and just coming over the circuits *B1* and *B2*. The former circuits have generated in them currents which tend to keep the magnet from moving away from them; that is currents which tend to pull the circuit after magnet. The latter circuits have generated in them currents which tend to keep the magnet from coming over the circuits; that is, currents which tend to push the circuits ahead of the magnet in its motion. The result is a tendency toward rotation of the disc and if free to move it will rotate. The faster the disc rotates, that is, the more nearly it approaches the speed of the rotating magnet, the less will be the relative speed of the magnet and disc and consequently the less will be the speed at which the lines of force due to the magnet will cut the disc. But the electromotive force, and therefore the current, generated in the disc diminishes as the rate of cutting of lines of force diminishes. Therefore the currents generated in the disc will be less as the relative speed of the magnet and disc diminish. That is, the more nearly the speed of the disc approaches that of the magnet the weaker will be the currents generated in the disc. The weaker the currents are in the disc the less the torque or drag which the magnet exerts on the disc to keep it in rotation. Starting from rest, therefore, the disc will gradually increase in speed until the torque or drag exerted on it by the magnet is just equal to that necessary for overcoming the friction of rotating the disc.

It is clear that the disc can never attain the same speed as the magnet, but must run at a somewhat lower speed. Its speed must be enough lower so that the rate at which the lines of force, due to the magnet, cut the disc will produce currents of sufficient strength to give the torque necessary for overcoming friction. It follows that if, having attained a steady speed, the disc have its friction increased by any means its speed will fall to such a point that the currents generated in it are just sufficient to produce the torque necessary for the increased friction load, and on the contrary, if having attained a steady speed the friction be diminished the disc will speed up until the currents induced in it are diminished to such a value as is just sufficient to produce the torque necessary for the decreased friction load.

So far we have considered a rotating magnetic field obtained by actually rotating a magnet, but it is clear that so far as the disc is concerned it makes no difference how the rotation of the magnetic field acting upon it is produced. The actions discussed above will be produced by any rotating field, and if we can produce such

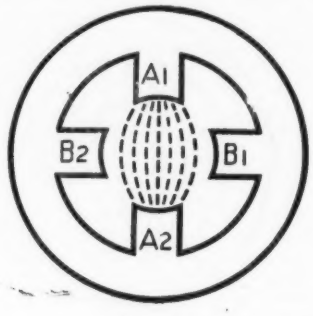


FIG. 3.

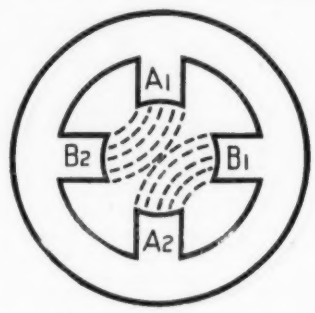


FIG. 4.

a field by any other means than that of actually rotating a magnet, we should expect the disc to be affected in precisely the same way as it is by the rotating magnet.

Consider the 4-pole field shown in Fig. 3. Suppose the poles A_1, A_2 and B_1, B_1, are wound with coils by passing current through which the poles may be magnetized. Suppose now the poles A_1 and A_2, be magnetized, A^1 being made a north pole and A_2 a south pole. There will then be produced a magnetic field between the poles A_1 and A_2 as shown by the dotted lines in Fig. 3. Suppose now the current magnetizing the poles A_1 and A_2 to continue flowing and the poles B_1 and B_2 be magnetized so that B_1 is a north pole and B_2 a south pole. The magnetic lines will then pass from the north pole, A_1, to the south pole B_2, and from the north pole B_1 to the south pole A_2, as shown in Fig. 4. Suppose now the current magnetizing the poles A_1 and A_2 be broken and that magnetizing B_1 and B_2 to continue flowing. Then the magnetic lines will pass between B_1 and B_2 only, as in Fig 5. B_1, as stated above, being a north pole. and B_2 a south pole.

Consider now what has happened in Figs. 3, 4 and 5. We started with *A1* a north pole and *A2* a south pole in Fig. 3; in Fig. 4 *A1* and *B1* were north poles and A2 and B2 south poles; in Fig. 5 *B1* was a north pole and *B2* a south pole. The magnetic field has been shifted from *A1 A2* to *B1 R2*—one-quarter of a revolution—in a way somewhat similar to that which it would be shifted if a magnet were rotated from the position *A1*, *A2* to the position *B1*, *B2*. The comparison would be still more nearly identical if the magnetizing current of *A1*, *A2* were gradually decreased from its maximum value to zero and that of *B1*, *B2* gradually increased from zero to its maximum value instead of being changed suddenly by making and breaking the circuit as described

above. If these changes were made gradually Fig. 4 would represent the condition where the current magnetizing *A1*, *A2* had diminished from its maximum value to a certain value intermediate between its maximum and zero, and the current magnetizing *B1*, *B2* had increased from its zero value until it had the same strength as the decreased current magnetizing *A1*, *A2*. Increasing and decreasing the currents gradually in this way would cause the condition which holds in Fig. 3 to merge gradually into that of Fig. 4, and the condition which holds in Fig. 4 to merge gradually into that of Fig. 5, instead of being attained by jumps as would be the case if the currents were simply made and broken as at first described.

It is evident that by continuing this procedure the magnetic field may be made to rotate continuously around the space included between the poles *A1*, *B1*, *A2*, *B2*. Following this out for another quarter revolution from the point shown in Fig. 5, *A1* would next become a south pole and *A2* a north pole, the strength of the two poles gradually increasing while that of *B1* and *B2* was decreasing, until *B1* and *A2* were equal north poles and *A1* and *B2* were equal south poles. The increase in the strength of *A1* and *A2* and the decrease in the strength of *B1* and *B2* would continue until *B1* and *B2* were not magnetized at all and *A1* and *A2* had attained their maximum strength, but in the opposite direction to that shown in Fig. 3. That is, *A2* would now be a north pole instead of a south pole, and *A1* would be a south pole instead of a north pole. These variations in magnetizing force have caused a more or less gradual rotation of the magnetic field produced by the poles *A1*, *A2*, *B1* and *B2* in a manner similar to that rotation which would be obtained if a permanent magnet were rotated so as to influence the space included between these poles.

So far we have assumed that the currents producing these magnetizations are direct currents, whose values controlled by rheostats

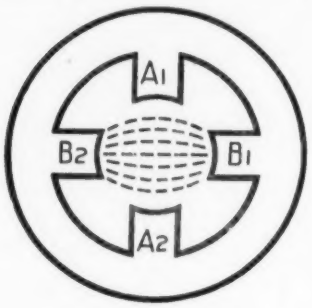


FIG. 5.

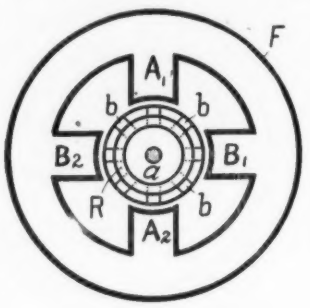


FIG. 7.

or otherwise, are made to vary between zero and a certain maximum, and from this maximum to zero again, at which point the connections are reversed and the current then increased to its maximum value in the opposite direction. It is not necessary, however, to use direct currents manipulated in this laborious fashion, as a 2-phase alternating current generator will supply currents which will pass through precisely the same values as those through which we have supposed the direct currents to pass.

Fig. 6 shows two curves which may be taken as representing the currents supplied by the two circuits of the 2-phase generator. The significance of Fig. 6 is as follows: Points on the line *XX* represent different positions of the generator armature producing the currents whose curves are *A* and *B*, just as points on the horizontal line in a steam engine indicator diagram represent different positions of the piston. The lengths of the lines 3, 4, 5, etc., represent the strength of the current flowing for the position of the armature to which they correspond, just as in an indicator diagram vertical lines represent steam pressure for the positions of the piston to which these lines correspond. For instance the length of the line 3 represents the strength of current flowing in one direction, which we will call the positive direction, in the circuit of curve *A*, while the line 7 represents the strength of current flowing in the opposite or negative direction in the circuit of *A*. Similarly the lines of 5 and 9 represent positive and negative currents in the circuit of *B*. Some lines, such as 4 and 5, represent currents in both of the circuits. These lines must be considered as made up of two superposed lines, one for the circuit of *A* and one for the circuit of *B*.

Referring again to the Figs. 3, 4 and 5, suppose that the poles *A1*, *A2* are magnetized by the current represented by the curve *A*, and that *B1* and *B2* are magnetized by the current of the curve *B*. Suppose that when the current of curve *A* has a positive value its direction in the coils magnetizing *A1*, *A2* is such as to make *A1* a north pole and *A2* a south pole. Then when the current of curve *A* has a negative value *A1* will be a south pole and *A2* a north pole. Similarly when the current of curve *B* is positive, *B1* will be a north pole and *B2* a south pole and when the current is negative *B1* will be a south pole and *B2* a north pole.

Now if we carefully follow out the values of the currents in circuits of *A* and *B* and their resultant magnetizations we will find that the magnetizations pass through the same changes as those which were described above in the case of the direct current. For instance, when the generator armature is in such position that the curves *A* and *B* have the values shown by the line 3 in Fig. 6, the magnetization in the 4-pole field will be that of Fig. 3, since, as Fig. 6 shows, the current at this instant in circuit *A* has a positive value equal to the length of the line 3, while the current in the circuit *B* is zero. When the position of the generator armature is such that the currents in the circuits *A* and *B* are those shown by the line 4 in Fig. 6 the magnetization in the 4-pole field is that shown by Fig. 4, since, as Fig. 6 shows, the currents in the circuits *A* and *B* are equal and both positive, each being equal to the length of the line 4. The line 5 in Fig. 6 represents the current conditions for Fig. 5, since the current in circuit *B* has risen to a positive value equal to the line 5, while the current in circuit *A* has fallen to zero. By continuing these steps we will find that by the time we have reached line 11 of Fig. 6 we shall have made a complete rotation of the magnetic field and arrived again at the condition of Fig. 3. For instance line 6 of Fig. 6 represents the condition where the currents in circuit *B* and circuit *A* are equal in values, but while that in *B* is positive that in *A* is negative, which corresponds to the condition where *B1* and *A2* are north poles and *A1* and *B2* are south poles. Line 7 of Fig. 6 shows that for the position of the generator armature at that instant the current in the circuit *A* has attained its full value, but in the negative direction, so that while *A1* and *A2*, only, are magnetized as

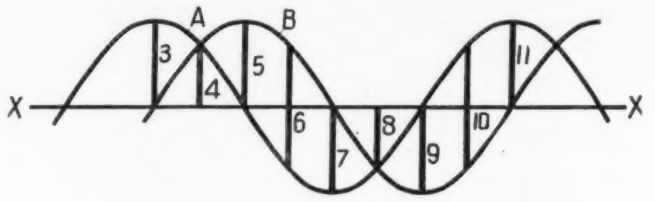


FIG. 6.

in Fig. 3, *A1* is a south pole and *A2* a north pole, whereas at the beginning *A1* was a north pole and *A2* a south pole. Line 8 of Fig. 6 shows that both of the currents in the two circuits are equal but both negative.

The 4-pole field shown in Fig. 3 will, therefore, if it have its poles properly wound with coils to which are supplied 2-phase alternating current, produce a rotating magnetic field. If in this field we place a closed conductor, free to rotate, we should expect it to behave as does the copper disc, above described, in the presence of the rotating magnet. If in this field we should place, instead of an armature, a solid copper cylinder provided with suitable shaft and bearings we should expect this cylinder to rotate and to be capable of carrying more or less load as a motor. If, however, instead of the solid copper cylinder we place in the field of Fig. 3 an iron cylinder, properly mounted on a shaft and bearings and having longitudinal holes or slots at its periphery in which are wound short-circuited coils, or in which are placed copper bars short circuited by rings at each end of the iron cylinder, the result obtained will be better than that in the case of the copper cylinder, since the iron cylinder will furnish a better path for the lines of force.

Let Fig. 7 represent a motor constructed in this way. *F* is the 4-pole field, which since it is acted upon by alternating currents, must be laminated, and *A* is a laminated iron cylinder provided with a shaft and bearings (not shown); *bbb*, etc., are copper bars placed in longitudinal slots in the periphery of the cylinder *A*, which we will call for the present the armature. The terms armature and field will for the present be used in describing these two elements, although as will be shown later, it were better to use the terms primary and secondary. The copper bars *bbb* are short circuited at each end of the armature by a ring, *R*, to which they are soldered or bolted. We have now a 2-phase induction motor

which will behave in a good deal the same way as the copper disc which has been discussed. Instead of the elementary circuits shown in Fig. 2 we have the copper bars and the closed circuits which they make through the end ring, and instead of the rotating magnet we have a rotating magnetic field produced by alternating currents.

Suppose the armature *A* to be at rest. On closing the switches which connect the windings of the field, *F*, with the 2-phase generator, a rotating field will be produced which will induce currents in the closed circuits formed by the bars and the short circuiting end rings of the armature *A*, and these currents will have such a direction as will tend to overcome or nullify the motion of the magnetic field producing them. That is, the direction of these currents will be such as will tend to produce a rotation of the armature *A*, which, if left free to move, will begin to rotate and gradually increase in speed of rotation until its speed approaches that of the rotating field which is sweeping around the interpolar space of the 4-pole field *F*. As in the case of the disc and rotating magnet, the final speed to which the armature setles down will depend upon the friction of its bearings. The greater the speed which it acquires the less will be the relative speed between it and the magnetic field, and consequently the weaker will be the currents induced in the short circuited winding. Its speed will, therefore, as in the case of the disc, increase to the point where the difference between its speed and that of the rotating field induces currents of strength just sufficient to produce a torque necessary for overcoming friction. If by means of a pulley and belt the armature be made to carry load it will slow down to such a point that the difference between its speed and that of the rotating field is sufficient for the generation in the short circuited winding of currents of sufficient strength to produce the torque necessary for carrying the load.

The difference between the speed of the armature *A* and that of the rotating field is generally designated as the "slip" of the motor, and the statements made above may be more concisely put by saying that for a given motor the amount of slip will depend upon the load carried by the motor, being greater as the load is greater and diminishing when the load diminishes. In commercial motors the slip is not quite proportionate to the increase in load. It increases somewhat more rapidly for a given increase of load when the motor is heavily loaded than when it is lightly loaded. The departure from proportionality is not, however, in a good motor, great, between no load and the load for which it is rated. Note that in the case of the motor, as in the case of the disc, the slip can never become zero; that is the speed of the armature can never become equal to that of the rotating field, because even with no external load there must be a great enough slip to generate in the armature, *A*, currents of sufficient strength to produce the torque necessary for overcoming friction.

From what has gone before it is clear that the speed of the armature *A* is equal to the speed of the rotating field, less the slip. Let us see on what the speed of the rotating field depends.

Refer to Fig. 6, representing the 2-phase alternating currents supplied to the motor. It has been shown that in passing from the values of the currents shown by the line 3 to the values indicated by the line 11 the rotating field is caused to make one complete revolution. Now from line 3 to line 11 is one complete cycle or period. The current *A* has started with a positive maximum value at 3, fallen to zero at 5, attained the negative maximum at 7, fallen to zero at 9 and finally attained at 11 a positive maximum equal to that at which it is started. The current *B* has started at zero at 3, attained a positive maximum at 5, fallen to zero at 7, reached a negative maximum at 9 and finally fallen to zero at 11. The zero value of *B* at 11 differs from that at 7 in that at 11 the value of *B* is changing from negative to positive, as it was at 3, whereas at 7 the value of *B* is changing from positive to negative. In other words, both of the curves have started from certain respective values at 3 and have returned again to those values at 11. It is clear, therefore, that a complete cycle causes one complete rotation of the magnetic field in such a motor as is shown in Fig. 3.

Now in such a motor each circuit from the generator supplies current to a pair of poles: the circuit in which the current *A*, Fig. 7, flows magnetizes the poles *A*1 and *A*2; the circuit in which the current *B* flows magnetizes the poles *B*1 and *B*2. Therefore in a 2-phase motor which has a pair of poles for each circuit of the 2-phase generator supplying the motor, there is one complete rotation of the magnetic field for each cycle of the alternating current supplied to it. If such a motor is supplied with alternating currents having a frequency of 60 cycles per second, or 3600 cycles per minute, the magnetic field will rotate at 3600 r. p. m. If it is supplied with a current having a frequency of 25 cycles per second, or 1500 cycles per minute, the field will rotate at a speed of 1500 r. p. m. The speeds above given are those of the rotating magnetic field. The corresponding speeds of the motor itself when loaded are equal to the speeds given diminished by the slip of the motor at full load. If the full load slip of the motor were in each case say 10 per cent., then each of the above speeds would have to be diminished by 10 per cent. in order to arrive at the full load speed of the corresponding motor. In commercial motors the slip at no load is so small, that is to say, the no-load speed is so nearly that of the rotating magnetic field, that the speed of the field is generally given as that of the motor at no load.

The concluding section of the paper will take up in detail the action of the induction motor viewed as a transformer, and when used with variable speeds.

Electrical Equipment of the Berlin, Germany, Elevated Railways.

The elevated railway system of Berlin, Germany, was put in operation in 1882, and the increase of traffic has been such that the management now is confronted with a condition that cannot possibly be met by steam traction, which has reached its maximum capacity on the present lines. The increase in traffic has averaged about 13 per cent. for each year from 1884 to 1897. In Fig. 1 the curves illustrate this increase, and from their character show that, in view of the present insufficiency of the system, the situation has arrived at an acute stage. The steady increase clearly indicates that it would be useless to consider plans whereby an increase of

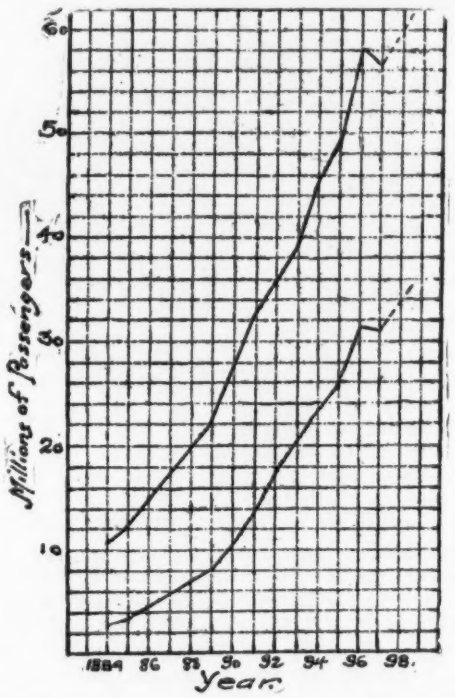


FIG. 1.—GROWTH OF TRAFFIC, BERLIN ELEVATED RAILWAYS.

capacity of only 20 or 30 per cent. might be obtained, because by the time the changes to accommodate that amount were made, the growth would have brought about the same condition that has to be met at present.

As a solution of the problem the Union Elektricitats Gesellschaft has presented proposals to the Administrator of Public Works for the replacement of steam traction by practically the same system of electric traction which has been so successful, both from the engineering and financial standpoint in Chicago—in other words, the Sprague system in all of its main details.

The advantage of the proposed system with particular reference to the problems to be met in Berlin is made clear by a consideration of the superiority of that system with respect to acceleration; that is to say, its greater traffic capacity when substituted for steam. In local steam service an acceleration of not more than .5 foot per second can be attained, and even less in the case of express service. On the other hand, an acceleration of 1.7 feet per second and even more is possible with the electric system. In

fact an experimental acceleration of 3 feet has been attained. This means that an electric express train can reach a speed of 50 miles an hour in less than a minute, while a steam train would take about five times as long. Moreover, as the distance between stops becomes smaller, the greater the importance this advantage assumes.

At present the Berlin trains normally consist of nine two-axle passenger cars and one steam locomotive. It is proposed during rush hours to run trains of eight four-axle motor cars, the capacity of each being 80 per cent. higher than that of the present cars. These trains would, therefore, correspond to 14.4 cars of the present capacity. In addition it is proposed to make up considerably longer trains, if later the traffic requirements demand it, which latter will be as easily controlled and will reach the same speed in accel-

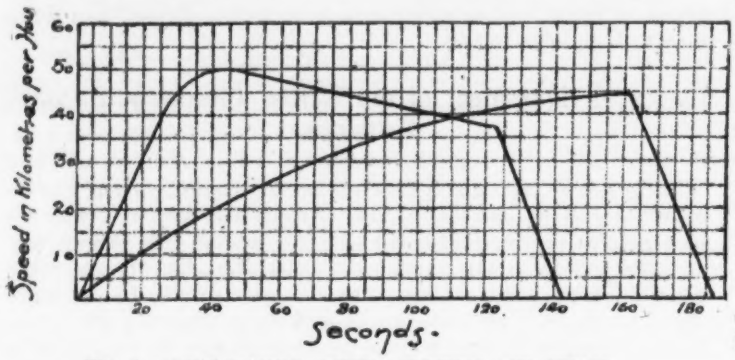


FIG. 2.—ACCELERATION CURVES, ELECTRIC AND STEAM.

eration as rapidly as the shorter trains or even as would a single car.

As an example of the time gained by an electric train, the following estimates are given, based upon regular stops of 30 seconds instead of 20 seconds as at present, and a maximum speed of 31.3 miles: From West End to Stralau, 34 against 44 minutes, giving a saving of time of 22.75 per cent. with the schedule speed increased from 14.7 to 17.2 miles per hour. From West End to West End, 69 against 86 minutes, giving a saving of 19.8 per cent. in time with an increase of schedule from 15 to 18.7 miles per hour. From Potsdam to Potsdam, 72 against 90 minutes, or a saving of 20 per cent. in time and an increase of schedule speed from 15.8 to 19.8 miles per hour. Supposing that in future trains of 12 cars be run so that they follow each other two minutes apart, the result would be an increase of capacity of 260 per cent. over the present service.

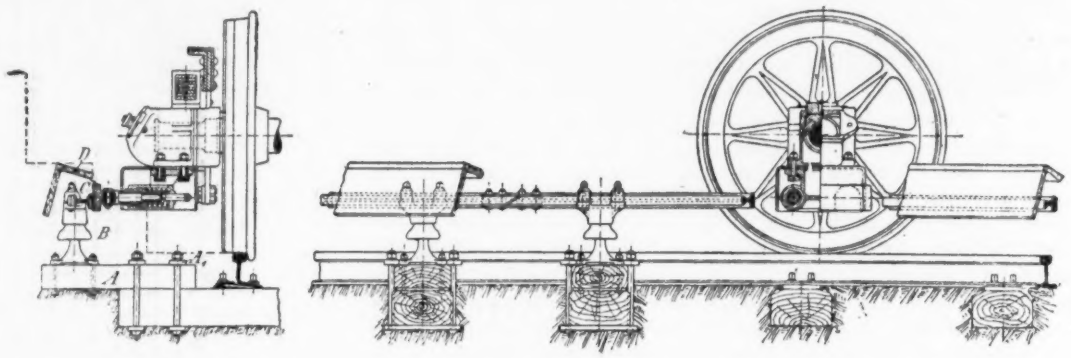
Fig. 2 represents the circuits of the present Berlin elevated road and Fig. 3 is a diagram comparing the service of the proposed electric trains with the present steam trains and illustrates the superior accelerating powers of the former. It will be seen that the electric train will reach its maximum speed of 50 kilometers in 40 seconds, while it requires 160 seconds for the steam train to reach its maximum speed of 45 kilometers per hour.

The main cause of the superiority of the proposed electric system lies in the fact that on the steam road the acceleration is limited by the proportion between the weight of the locomotive and that of the train. That is, the heavier the locomotive and the lighter the train, the quicker the acceleration possible. It follows that a train of two locomotives will start more quickly than a train with one, and that if the train were composed entirely of locomotives, the quickest start possible would be made. This latter condition is the one which exists in the case of the Sprague system, where each car is supplied with its own motors, the result being that the acceleration of the whole train is the same as that which may be obtained with a single motor car. With respect to adhesive weight, with every other axle driven, about 60 per cent. of the weight of the train is utilized. Even under unfavorable conditions with respect to track and assuming an adhesive limit of 12 per cent., the maximum acceleration possible would be 2.3 feet per second. As the plans submitted propose an acceleration of only 1.52 per second it will be seen that this is well within the limit.

It is proposed to generate electrical energy for the entire system in two large power stations which will supply direct current on the three-wire system with 1200 volts between the outers. The reasons for using a direct-current three-wire system instead of alternating currents for transmission and with rotaries, are that it was not regarded advisable to make the whole line dependent upon a single power station; and if two stations are built and properly located, the necessary conditions are present to justify the use of the direct-current system. That is to say, under these conditions, the distributing system will be cheaper than if the alternating-current system were used. As justifying the use of storage batteries, it is pointed out that a train of eight motor cars would take during the time of acceleration a current of not less than 4000 amperes at 600 volts, thus giving rise to great fluctuations on the line which would be taken up by the storage batteries.

Each of the two power stations will contain at the beginning 10 direct-current shunt dynamos, each of a normal capacity of 750-kw and direct-connected in pairs to triple-expansion engines developing normally 2000-hp, with an overload capacity up to 2500-hp. The stations will be equipped with all modern apparatus securing the highest economy, including condensers, economizers, superheaters, mechanical stokers, coal handling apparatus, etc. The water for one of the power stations will be taken from a well, the condenser water supply being cooled in towers. The other station will use jet condensers, taking the water necessary for them from the River Spree by means of a canal.

The track and conductor system is shown in Figs. 4 and 5. The conductor rails, *C*, are supported by insulators, *B*, fastened to creosoted blocks, *A*. To provide against accidental contacts, the rails are covered with wooden roofing, *D*. As will be seen, contact conductor is made on the side of the conductor rail, the advantage of this arrangement being that dirt, snow and water will



FIGS. 4 AND 5.—CONTACT RAIL, BERLIN ELEVATED RAILWAY.

not stay as easily on a vertical as on a horizontal surface, and the contact shoe will move more steadily. The dimensions of the rail will be such that on each side of the three-wire system there will be a maximum drop of 50 volts or an average drop of 25 volts.

There will be 38 substations, each having a battery of 550 cells with a capacity of 800 amperes on the one-hour rate. There will

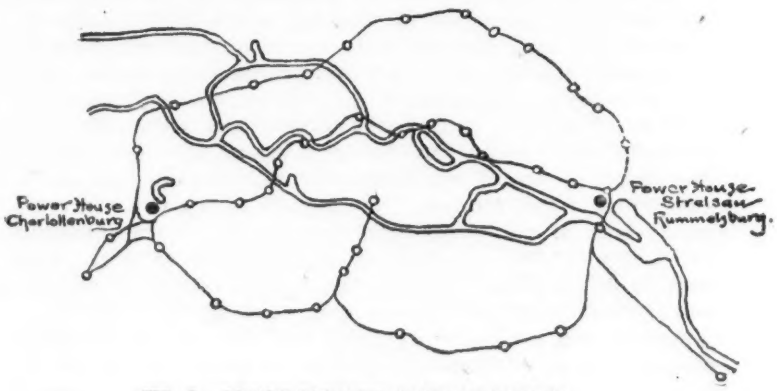


FIG. 3.—BERLIN ELEVATED RAILWAY SYSTEM.

also be in the stations a booster and motor for charging the batteries during the night. All the batteries together will give about 40,000 kw-hours if discharged in five hours. That is to say, they

can safely take the full load of one of the power stations for this time.

The equipment of the four-axle motor cars consists of two 175-hp motors weighing 2.4 tons, including gears and gear cases. The usual Sprague system of controllers operated by small pilot motors will be employed, the controllers being placed under the cars and the pilot motors operated from the car platform by a motorman.

The estimate for the electrical equipment of the Berlin lines is $10,750,000, the items of which are as follows: Land, $260,000; buildings, $490,000; generating machinery, $1,700,000; distributing system, $1,720,000; storage batteries, $1,500,000; motor cars, $4,750,000; other expenses, $380,000. The investment per unit of service is smaller for electric than for steam service, while the electric service will be 28 per cent. cheaper than steam service.

American Types of Automobiles.—VII

HUB MOTOR ELECTRIC VEHICLE.

THOSE who are familiar with the history of electric traction will remember that various ingenious attempts were made from time to time to get away from all methods of placing the motors under the car, or on the platform, or on the floor, or in a separate locomotive—by building the motor right into the wheels of the vehicle. As will also be borne in mind, none of these ingenious and interesting attempts were attended by success, and all of them have disappeared off the face of the earth. It does not follow, however, by any means, that analogous methods may not prove efficient and practical when applied in the field of automobilism, and attention has now been called to the vehicle of the Hub Motor Company, of Chicago, as exhibited recently in the City of Cleveland, O., by Messrs. Charles Berg and H. L. Irwin, with the co-operation of their mechanical engineers, Messrs. Newman and Ledwinka. At first thought, the greater multiplicity of motors might be deemed objectionable, but it is noteworthy that many well known types hitherto run with one motor have lately been resorting to two; while if we understand Prof. Elihu Thomson aright, he gave expression recently to his preference for four motors, one driving each wheel. Be this as it may, the Hub designers have put a small motor right into each hub, encasing with it a very compact double-reduction gear.

FIG. 1.—HUB MOTOR VEHICLE.

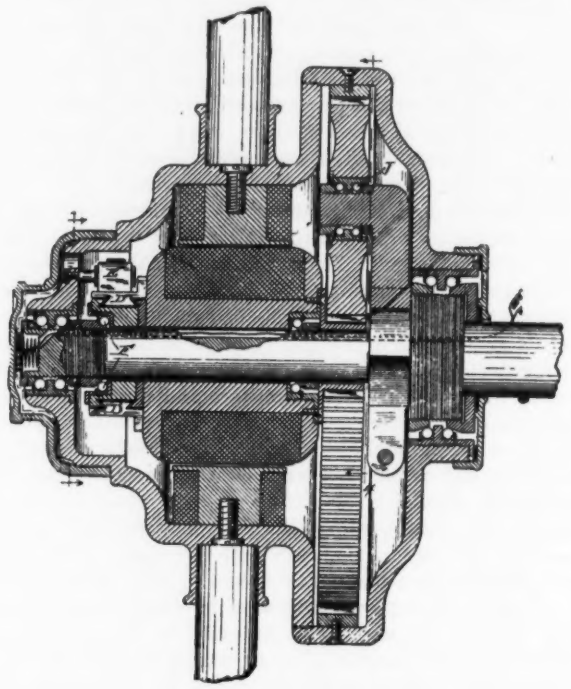


FIG. 2.—THE HUB MOTOR.

The Hub surrey shown herewith has four motors, each of a four-pole type, developing a normal 1½ brake-hp. The hubs measure only 10½ inches in exterior diameter. The batteries are storage, 40 cells being used of 80 amp.-hours at a 3-hour discharge rate. The wheels are 43 inches in diameter, of wood, with 3-inch Stodder unpuncturable pneumatic tires. The total weight of the vehicle is put at 3000 pounds.

With regard to the novel plan adopted, the designers say they had for a long time considered what they speak of as imperfections in other vehicles, and the one which suggested itself as being foremost is the difficulty experienced in handling the traction question in long and heavy vehicles; namely, in making each wheel a driving unit. The steering gear interfered with equipping the steering wheel, and the natural place they thought, therefore, to place the motors, was in the hubs. And at the same time they believed that this had an added advantage in doing away with visible machinery; hence making a light appearing vehicle. The same method would also protect the mechanism from water and dust.

Relative to four-motor equipment, it is presumable that four motors consume more power than one or two. They admit this to be correct when traction and overload factors are considered. When an ordinary two-seated vehicle has its weight properly distributed, only 60 per cent. of the weight of the vehicle is available for traction, while 40 per cent. is dead or idle weight. In securing the strength and efficiency of a vehicle motor, one must remember that the motor is not worked to its full limit on a boulevard, but with only 60 per cent. of its rating. When the efficiency of a motor is considered, it is well known that it is highest when worked at its rated capacity. The Hub Company claim that they can operate their motors nearer the rated capacity on level roads than others, for the combined horse-power can be less, since the four points of contact will allow better traction when muddy roads or heavy grades are met with. If this is true, that they can run their motors on level roads nearer the rated capacity, it would follow that they can run them at a more economical point than others. When bad roads or hills are encountered, the four points of contact allow this vehicle to run on less power than if only one set of wheels were equipped.

In starting, the current maximum is low, and therefore the strain on the accumulators is lessened. In the matter of repairs, it is claimed also that there are advantages in this style of construction, because the equipment is compact in each hub, just as the bearings of a bicycle, and the gears cannot be thrown out of mesh and rattle, as is the case when long pinion shafts are used to transmit the power to a gear on a vehicle wheel. All suspension details are done away with, and this reduces the multiplicity of parts. The strain on the motors is less than with vehicles carrying idle weight, and this reduces the repair account. They can remove any wheel with the enclosed mechanism in a very few minutes and substitute another unit, or an ordinary carriage wheel, if necessary. This is a very important point, when dollars and cents are considered, as in case of a breakdown the whole vehicle is not laid up for repairs, but only one or two hubs, as the case may be. The machine can be run with one motor, and can go at ordinary speed on two. The Hub designers state that they have proven all these points from actual experience and tests.

The motors are connected in series with the batteries, but in parallel with each other. The construction in detail is shown in the detail cut herewith. We are informed that the surrey has demonstrated its ability very satisfactorily on grades up to not less than 18 per cent.

Some Recent Telephone Patents.

Among the patents issued January 16 and 23 are nine in the class of telephony, ranging in subject from details of a telephonic instrument to telephone exchange systems.

In Fig. 1 is illustrated a granulated carbon microphone, upon which a patent was granted to Julius O. Zwarg, of Freiburg, Germany. In contact with the diaphragm is a disc having inclined perforations communicating with a granulated carbon chamber in the rear. It is claimed that the great number of holes increases the contact surface and consequently decreases the electrical resistance between the carbon and the diaphragm so that the call-bell current may easily pass.

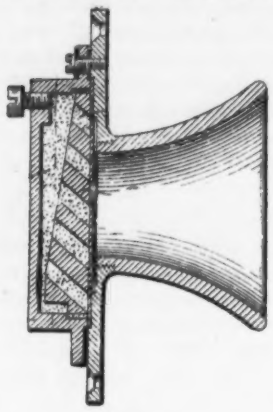


FIG. 1.

Fig. 2 is a diagram accompanying a patent issued to David H. Wilson on a telephone system embodying as one of its elements a new construction of the induction coil element. The induction coil consists of a permanent magnet having opposed pole pieces, between which are mounted two separate coils wound upon a core of magnetic material forming part of the magnetic circuit of the permanent magnet. This core is rotatably mounted, the coils being supplied with commutators, and does away with extra signaling devices. One of the coils is a primary coil which is connected in the main circuit between the two stations when the talking circuit is completed. The other coil is a secondary which is connected in a local secondary circuit with its associated receiver. The system includes a signaling device normally in the main circuit and so arranged in connection with a switching device that the latter may disconnect it from the main circuit and connect the transmitters and the primary coil in the main circuit and close the secondary circuit. The local secondary circuit of each instrument is normally open; the receiver arm switch when the receiver is removed disconnects the signaling devices from the main circuit, closes the local secondary circuit and connects the transmitters and the primary coils of the induction coils in the main circuit. The primary circuit constitutes the main line of the system, and the source of electric supply and transmitter are in this main line, while the receiver is in a local secondary circuit.

When it is desired to call up the distant station the core is rotated and thus a series of impulses sent out upon the line. When the receivers are taken from the hooks the talking circuit is completed, a current then being generated in the local secondary circuit of the distant receiver. It is claimed that by this arrangement highly satisfactory results may be obtained with very little current. Since the primary circuit is the main line, it is only necessary to

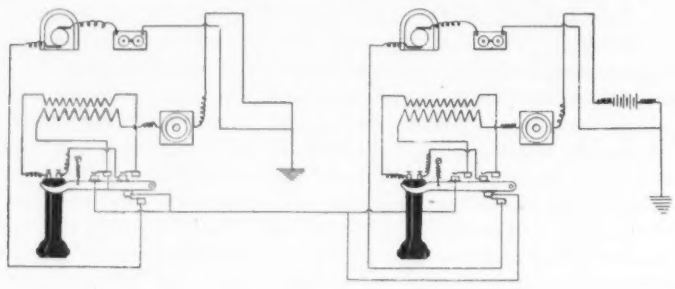


FIG. 2.

have a battery at one end of the line, thus doing away with the large number of sources of electric supply now employed.

Another patent granted to the same inventor gives further details of the system, as illustrated in Fig. 3.

A patent granted to A. A. Low has for its object to obviate the necessity of lifting a receiver from its arm to cut out the call and throw in circuit the receiver. In Fig. 4 the arrangement is shown applied to a call box of ordinary construction. The receiver is mounted on a stand, a weight (shaped like a receiver) replacing it on the hook. When the receiver stand is in operative position for hearing (with respect to the transmitter) the talking circuit connection is made. When the stand is pushed back the receiver is automatically disconnected. As will be seen, the hook weight rests on an inclined plane forming part of the receiver stand.

In Fig. 5. is illustrated diagrammatically a telephone system on

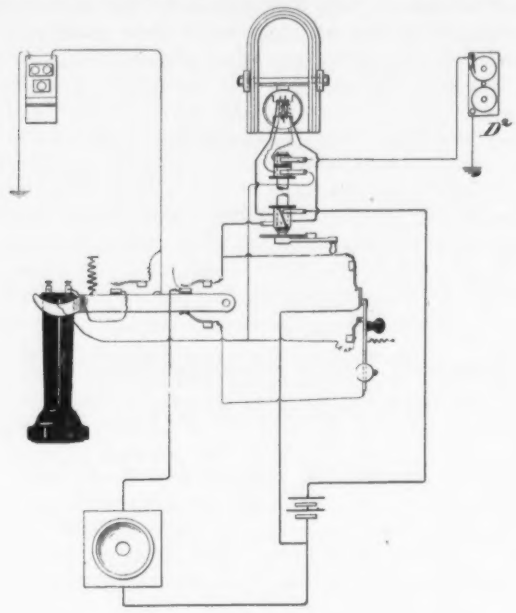


FIG. 3.

which a patent was granted to Frank R. McBerty. The invention applies to switching systems in which subsidiary signals in the switchboard are controlled through the agency of a relay connected with the line and responsive to currents determined by the position of appliances at the substation, consisting of repeating coils(one for each line) which render the signals of two connected lines independently responsive to currents in the corresponding lines, the repeating coils being furnished with moving parts to serve as relays. The object of the present improvement is to so arrange the circuits of the lines and repeating coils in connection with the line jacks and answering jacks of the lines that no more than one repeating coil shall at any time be included in a telephonic circuit between two stations, although the repeating coils of both lines remain effective for operating signals. A further object is to so arrange the signals that one of them shall serve to call for disconnection only, the other indicating the condition of the substation appliances of the called line. This is accomplished by leading the secondary winding of one of the repeating coils directly to the answering-jack of a subscriber's line and connecting the line circuits or terminals

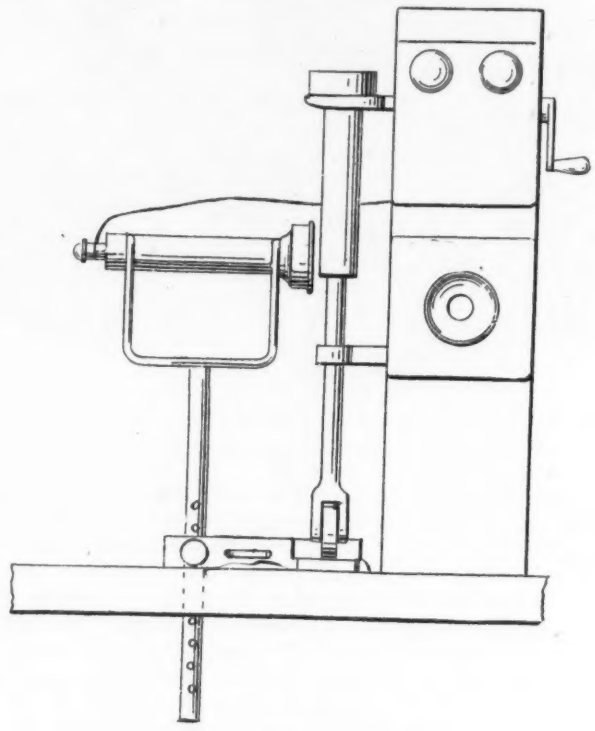


FIG. 4.

of the primary winding of the repeating coil with the line-jacks of the subscriber's line, so that when two lines are united for conversation by means of a plug inserted in the answering-jack of the calling line and another plug in the line-jack of the correspondent line, the telephonic circuit involves only the repeating coil with the calling line. The repeating coils of both lines remain in connection with their respective line conductors, however, and both retain their functions in controlling subsidiary signals. A close reading of the entire patent is necessary for a full understanding of the details.

A patent granted to Thos. C. Wales, Jr., relates to exchange switchboard apparatus and appliances with respect to the structure

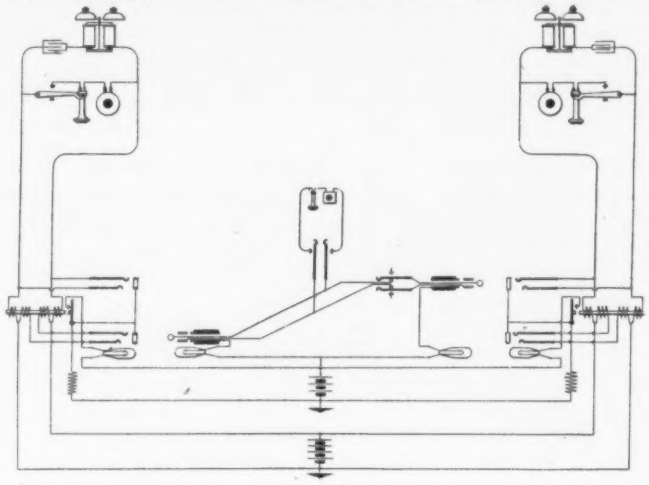


FIG. 5.

and arrangement of call signal devices for directing the attention of central station operators preparatory to a request that the calling line shall be switched to some other substation line for through telephonic connection. Owing to the detailed nature of the specifications, they do not admit of brief abstract.

A patent granted to Frank B. Cook relates to that class of switchboard apparatus by which a connection is established for conversation between the line of two subscribers, by which the operator may be notified to disconnect the lines by either one of the subscribers when conversation is completed. The object of the invention is to retain the advantages of the present method of accomplishing this purpose, but to dispense entirely with a separate clearing-out signal, one of the calling signal devices being employed for a clearing-out signaling device, and without requiring the exercise of any special skill or judgment upon the part of the operator. Referring to Fig. 6, the device consists of a spring-jack switch comprising a main contact-strip and a supplemental contact strip of different relative dimensions, and also plugs of different relative dimensions. One of the plugs is of such a dimension that when inserted it makes contact with the main strip only, and the other

FIG. 6.

plug of a dimension to make contact with the supplemental strip.

Two patents were granted for registering apparatus for taking account of the number of calls over a line. One of these, granted to Frank R. McBerty, involves the use of a controlling magnet which can respond but once during each connection, its circuits being changed in its first act to prevent its subsequent operation in order that the same use of a telephone may not be counted more than once. Another patent granted to George K. Thompson has the same object, and also employs a controlling electromagnet to accomplish its purpose.

Cleaning Up the Michigan Independent Telephones.

President Glidden, of the Erie Telephone Company, which recently absorbed extensive non-Bell telephone property in Michigan, has announced the purchase of three additional companies in that state. They are the Central Telephone Company, Kalamazoo Telephone Company, and the Dowagiac Telephone Company.

These companies have been in existence for three years, and have heretofore been operated in opposition to the Bell interests. They have ten exchanges, including the City of Kalamazoo. The Central Telephone Company was a long-distance independent company extending from Kalamazoo to various Michigan towns. The consideration involved in the deal is not stated.

The name of President H. A. Everett, of the Federal Telephone Company, of Cleveland, who is interested in the Detroit Telephone Company, was freely used as that of a willing party to the recent deals. Mr. Everett informs us that this was entirely without authority or accuracy, and that he is pushing his independent telephone interests actively. He is opposed to the recent consolidations.

Pacific Cable Data.

Official reports received by Rear Admiral Bradford, Chief of the Bureau of Equipment, from Lieutenant Commander H. M. Hodges, commander of the Nero, announce the feasibility of a cable route across the Pacific, connecting San Francisco, Honolulu, Midway Islands, Guam, Luzon and Yokohama. The Nero surveyed between Guam and Luzon, and then ran back to Guam, pursuing a zigzag course, in order to sound along the route selected, with a view to obtaining the best possible location for the cable. Then she ran a straight course to Yokohama. She returned zigzagging to Guam, and will zigzag across the line to the Midway Islands and to Honolulu, when her work will be completed.

The Nero has found a depth of less than three thousand fathoms between Yokohama and Guam and Luzon and Guam. Three thousand fathoms is the extreme depth the apthorities were willing to lay the cable.

The cable between Honolulu and Dongala Bay, which is the Luzon terminus of the cable line, will be 4812 knots long. Only two offsets from the projected great circle route between the Midway Islands and Guam were found necessary to avoid obstacles to successful laying and operation of the cable. The first was a submarine mountain a short distance west of the Midway Islands, and the second an abyss more than forty-nine hundred fathoms deep, found about five hundred miles east of Guam.

Discussing Capt. G. O. Squier's recent Institute paper, Vice-President Ward, of the Commercial Cable Company, said recently: "He does not allow for a duplicate cable as a part of the government system, and yet no cable system can possibly be successful without a second line. Therefore the 'reserve fund and interest on capital, $400,000,' and '200 miles of additional cable, $200,000 annually,' as laid down by Captain Squier, must be doubted. The cost per annum will then be:

Total annual cost of operation of one cable, including maintenance of repair ships, spare cable and reserve fund and interest on capital, as per Captain Squier's figures	$925,000
Reserve fund and interest on capital ($12,000,000) second cable	400,000
Two hundred miles additional cable required annually at $1000 per mile	200,000
Total	$1,525,000

"This sum is exclusive of extra operating expenses for the second cable, and I doubt if the additional two hundred miles of cable required annually will cost much less than $1500 a mile.

CURRENT NEWS AND NOTES.

ANTARCTIC EXPEDITION.—The ship now being built at the Howaldt shipbuilding yard, Kiel, for the German Antarctic Expedition, is to be lighted throughout by electricity, and the current will be used for other purposes. A model of the vessel will be shown at the Paris Exposition.

WATER, LIGHT AND TALK.—One of the most remarkable examples of municipal ownership in the Unted States is shown by the town reports of Edinburg, Ind. Incandescent electric lights are furnished to residences for 15 cents a month and to business houses for 20 cents a month for 16-cp lights. Waterworks are also operated at an annual charge of $1 to each consumer, and a complete and perfect telephone exchange is maintained with a monthly rental of 50 cents.

LORD RAYLEIGH, speaking at the Royal Institution, recently, said: "I agree with Hiram Maxim that a solution of the problem of aerial flight is only a question of money. Maxim has overcome many of the difficulties himself. There are many birds which seem able to maintain themselves with little apparent effort. It is all a question of relative motion, as a uniform horizontal wind is of no use to the sailing bird. There has been a good deal of scepticism as to whether it is a matter of suction from above, but I have conclusively proved by experiment that is the case."

THE LATE DANA GREENE.—In the general order issued from the headquarters of the Naval Militia announcing the death of Lieutenant Commander Greene occurs the following: "At the outbreak of the war, when chief of staff, he accepted, at a day's notice, subordinate rank in order to be with his old command, and served with distinction on board the U. S. S. Yankee. The commanding officer of that vessel especially commended his professional qualities and his coolness in battle. At the close of the war the governor, in token of his faultless record, appointed him on his staff to represent the Naval Militia. The service has lost one of its finest officers and the country one of its most patriotic and unselfish citizens."

WIRELESS TELEGRAPHY.—The English army surgeons' employment of the Röntgen rays in field surgery has proved most successful, and has met with the highest commendation. Orders have been received for a fresh equipment and skilled operators, and before February it is likely that every column at the front will be furnished with a Röntgen ray outfit. Wireless telegraphy is also rapidly gaining ground. Marconi outfits are being installed on three British vessels destined for active service, as well as on the passenger steamers in the English Channel. It is announced from Spain that a Major Cervera has been exhibiting wireless telegraph apparatus of his own invention before King Alfonso and the Queen Regent.

THE CABLES THAT DEWEY CUT.—President McKinley on Jan. 16 transmitted to Congress the claim of the Eastern Extension Telegraph Company, amounting to $4,334, for compensation on account of expenses in repairing the cables between Manila and Hong Kong, and Manila and Iloilo, cut by orders of Admiral Dewey during the Spanish war. The claim is presented by the British government through the Department of State, and Secretary Hay, in transmitting it, appends an opinion of the Attorney General that it has no standing in law. The Secretary, however, turns the claim over to Congress in order that it may determine whether or not, as an act of comity and equity, the company should be reimbursed for actual expenses in repairing the cables.

THE TROLLEY IN THE CITY OF MEXICO.—The new electric railway line in the capital city of Mexico was opened on Jan. 15. From all along the trolley car route, through the city, to the Zocalo, or old historic plaza, came crowds of people on the day of inauguration to gaze at and often follow the cars. Trial trips had been made only in the dead of night to teach young Mexicans to manage the motors. At first applicants to learn were not over-abundant, as many were alarmed at the idea of handling the new cars, but now there will be no scarcity of "maquinistas," as the motormen are called, for the want of a better term. Every trolley car is crowded with passengers eager to make a first trip. Indians throng the streets and the whole city has the air of a "semana de fiestas," or week of holidays.

IMPROVED CONSTRUCTION OF ROTARY CONVERTERS AND DOUBLE-CURRENT GENERATORS.—A patent issued Jan. 23 to W. L. R. Emmet describes an improvement in the construction of rotary converters, double-current generators and other types of dynamo machines possessing both collectors and commutating devices, the object being to economize the space occupied by these machines, enable them to be made with shorter shafts, and have greater rigidity. The commutator and collector rings are both placed on one side of the machine. The commutator is secured to the spider or other part of the armature structure, and the collector rings are placed directly upon the shaft. As illustrated, the commutator is an annular construction supported by brackets from the armature spider, and overhangs collector rings secured directly to the shaft.

SAVING LIFE BY TELEPHONE.—A special despatch from Wilkesbarre, Pa., on Jan. 22, says: David Culver, ferryman at Forty Fort, and two small boys, had a narrow escape from death this afternoon. The river has risen 15 feet since last Friday, and is flowing very swiftly. The ice passed out last night, and this afternoon Culver tried to take his ferry across the river. Two small boys were with him. In the middle of the river the big ferry was swept free of the guide ropes with a jerk and carried down the river. As the ferry approached the bridge here, its three passengers shouting for help, a crowd gathered, but could do nothing. Rapidly they were swept down the river toward the Nanticoke Dam, seven miles away. There was but one way to save them. Telephone messages were sent to Plymouth, three miles down the river, and by the time the ferry reached there several boats dashed out to the rescue. Two reached the ferry, caught a rope, and, after a hard battle with the current, drew the boat in shore.

POLYPHASE ARC LAMP.—A patent was issued Jan. 23 to E. W. Rice, Jr., on an arc lamp for use on polyphase circuits, and having two or more stationary electrodes and a single adjustable electrode. In the case of a lamp for three-phase circuits, there are three stationary electrodes, connected respectively with the three wires of the three-phase circuit. The fourth electrode is larger in diameter than the stationary ones, is adjustable for regulation, and is connected to a point electrically symmetrical with the three main wires. That is, should the three-phase system have a neutral wire running from the common point of a star winding, the adjustable electrode would connect with this wire; it would also appear that a "Y" box similar to that used with wattmeters might be employed in order to obtain the symmetrical point. The regulating coil will be energized by the current from this fourth conductor and will strike the arc in a manner similar to the ordinary operation of any arc lamp. The arc will be maintained between the movable electrode and each of the three stationary electrodes, and as the sum of the three currents is a constant value, the luminosity of the arc will be fairly constant at very low frequencies.

LIEUT. PAUL D. STOCKLY MISSING.—General Otis has cabled the War Department as follows: "Manila, Jan. 24.—Lieut. Stockly, Twenty-first Infantry, has been missing since the 12th inst. He was on reconnoitring duty at Talisay, near San Tomas, Batangas, and was evidently captured. Search is still being prosecuted." Paul Devereaux Stockly, twenty-four years of age, is the son of George W. Stockly, president of the Sims-Dudley Defense Company, of 120 Liberty Street, New York. He was appointed second lieutenant of the Twenty-first, Aug. 22, 1899, and owed his commission to the fact that he possessed a thorough knowledge of the use of the dynamite gun, with which he went to Cuba and Puerto Rico in behalf of the government during the Spanish war. With Lieut. M. C. Buckey, of the Third Artillery, Lieut. Stockly superintended the loading of dynamite guns at New York for Manila, and was then ordered to Europe and afterward to Manila to report to General Otis. His father is well known in electrical circles as the president of the famous pioneer Brush Electric Company. While Lieut. Stockly is believed to be quite safe, his family and friends have the fullest sympathy of the public in this unfortunate event.

MONOCYCLIC TEASER SYSTEM.—In a patent granted Jan. 23 to Charles P. Steinmetz, an addition to the monocyclic system is described, consisting of means for starting from the single-phase mains the phase-transformers employed with that system, and for compensating for wattless magnetizing current when running. In the monocyclic system a device such as the induction motor is used for producing a difference of phase in the current flowing in the third or teaser wire. Such a motor is operated with two primary windings, one being connected to the single-phase mains, while the second has one end connected to the middle of the first winding, and the free end to the teaser conductor. The improvement on the above method consists of connecting a condenser between the teaser wire and one of the mains. Under the former system, if no motors are operating on the teaser circuit, the phase transformer can receive only a single-phase current from the mains, and is, therefore, not self-starting. By connecting the condenser as described, the leading current from it, combined with the main current, gives sufficient torque for purposes of starting; and when the phase transformer is running, it compensates for the magnetizing current supplied thereto.

BILL FOR CUTTING CUBAN CABLES.—President McKinley on Jan. 23 sent to Congress the claim of the Cuba Submarine Telegraph Company for $40,870, for expenses incurred in repairing cables and property destroyed by American war vessels during the war with Spain. The claim was presented through the British Foreign Office and the State Department.

ALUMINUM ARC-LIGHT ELECTRODES.—In a patent issued Jan. 23 to G. Heidel, a negative arc-light pencil is described made of aluminum instead of carbon. The patentee says he has discovered that by the use of an aluminum negative in connection with a carbon positive, he is enabled to produce a light of increased efficiency, for the reason that the combustion of the aluminum is very gradual and the consumption of the carbon pencils very complete, practically the entire carbon positive being consumed. The life of the aluminum pencil is many times that of the carbon pencil, which results in a material saving in the quantity of pencils and in the labor of replacing the same.

A HANDSOME SOUVENIR.—On the occasion last fall of the visit of the English Institution of Electrical Engineers to the Oerlikon Works, near Zurich, Switzerland, each member was presented a handsome souvenir in the form of an album containing 100 or more half-tone engravings representing the more important types of machines manufactured by the company and illustrating a number of the larger plants it has installed in the territory to be visited by the members of the Institution. The album is bound in illuminated covers bearing the inscription, "Institution of Electrical Engineers. Meeting, September, 1899. With compliments of the Maschinenfabrik Oerlikon."

CENTRAL STATION RATES IN CINCINNATI.—Beginning with the new year the Cincinnati Edison Electric Company has made notable reductions in its rates for light and motor service. The base rate on lighting service has been reduced from 15 to 10 cents per kw-hour, and a more liberal system of discounts instituted. For twenty-six days' service per month, the charge for lighting service one hour each day is 13 cents for a 16-cp lamp; the rate decreases for each hour of longer service, becoming 9.9 cents for five hours and 7.8 cents for ten hours' service each day. An additional discount of 5 per cent. is allowed for cash payment in five days. The power rates are also based on 10 cents per kw-hour with a minimum charge of $1 per month for each rated horse-power capacity of motor installation. The discounts vary from 10 per cent. for 100 kw-hours per month to 60 per cent. when over 800 kw-hours per month are used. Five per cent. in addition is allowed when payment is made before the fifth day after date of bill.

LETTERS TO THE EDITORS.

Parallel Operation of Direct-Connected Alternators.

To the Editors of Electrical World and Engineer:

Sirs:—Having read Mr. W. L. R. Emmet's valuable article on parallel running of direct-coupled alternators, which appeared in the ELECTRICAL WORLD AND ENGINEER of Jan. 20, 1900, it occurred to me that perhaps other testimony on so important a subject might prove of interest.

For about two years the company with which I am connected has operated in parallel in one station two units, which I will call *A* and *B*. The unit *A* consists of a 1500-hp horizontal cross-compound Hamilton-Corliss engine provided with a centrifugal ball governor, this engine being direct-connected to a General Electric 750-kw, 25-cycle, three-phase, 6600-volt alternator, whose normal speed is 83.3 revolutions per minute. *B* consists of a 3000-hp horizontal double-tandem compound Mackintosh & Seymour engine with a shaft governor, this engine being direct-coupled to a General Electric 1500-kw, 25-cycle, three-phase, 6600-volt alternator, whose normal speed is 75 revolutions per minute.

The two cranks of each engine are set at the same angle to each other, and unit *A* is provided with a 50-ton flywheel, while unit *B* is provided with an 80-ton flywheel.

We began our operations of throwing the two units into parallel by using an artificial load, bringing the alternators into synchronism by means of the engine throttle.

We found no difficulty in throwing the units together in parallel, but upon attempting to change the load from one unit to another, the cross current became so great that we were obliged to separate the units.

We then desired to make the governor of the Hamilton-Corliss engine more sluggish in its action by changing the oil in the governor dashpot, and we also decided that the speed of the engine must be controlled from the electrical gallery.

This latter object was accomplished by attaching to a part of the Hamilton-Corliss governor an electrical motor in such a manner that the operation of this motor moved a weight backward and forward, changing the speed about 4 per cent. above and below the normal.

Having accomplished these two ends, we were enabled to throw the units into parallel without difficulty, each unit, however, being loaded to at least one-half of its rated capacity, this load being either inductive or non-inductive. With no load on one unit and full load on the other unit, we at present find it a somewhat difficult matter to synchronize well. This is owing to the fact that we have a speed changing device on only one unit, and the range of this device not being great enough, it is necessary to change the speed by means of the engine throttle. These units are being synchronized every day, however, although it is sometimes necessary to separate and try again.

It is found that after having been accurately placed in parallel, the units operate very well together, and with very little cross-current, even with quite an inductive load. The cross-current can be almost entirely eliminated by judiciously regulating the field excitation of the two alternators.

Should it be desired to change the load from one unit to the other unit, or to divide the load equally between the two units, the desired effect is produced by means of the speed-changing device, the field excitation being changed only to eliminate the cross-current, and not to shift the load.

In conclusion, it would seem that successful parallel operation of direct-connected alternators is best provided for by having the governors of the engines made sluggish to sudden variations of speed; the speed control of the engine should rest with the electrical switchboard attendant; the variation in angular velocity should be made as small as possible by moderately heavy flywheels and by increasing the number of cranks as far as possible.

Under the above conditions, alternators of the same voltage and frequency, and of approximately the same inherent regulation, should operate well in parallel.

F. G. SYKES.

BROOKLYN, N. Y.

Alternating Current Series Arc Lighting.

To the Editors of Electrical World and Engineer:

Sirs:—Referring to the letter of Prof. Elihu Thomson in your issue of Dec. 30, in criticism of my communication printed in your issue of Dec. 16, the latter was written to call attention to the fact that notwithstanding Prof. Thomson's early work on self-regulating transformers, no useful application of his experiments had been made in America for series arc lighting until lately, as appeared from an article in your columns to which I referred.

On the contrary, so thoroughly had the subject been worked out by Mr. Ferranti in England, that a considerable amount of public arc lighting was done some five years ago, and the system has since been largely applied throughout this country.

The constant-current transformers were combined with a very efficient form of rectifier, and thus we have many alternating-current stations supplying first-class direct-current series arc lighting, with only one class of generating plant in the station.

There is little doubt as to the superiority of direct-current series arc lighting over alternating current, and still less doubt as to the desirability of one class of generating plant in the station; and both these conditions are met by the Ferranti rectifier system.

HOPE, DERBYSHIRE, ENGLAND. HENRY W. CLOTHIER.

Paralleling of Compound-Wound Generators.

To the Editors of Electrical World and Engineer.

Sirs:—I have been interested in the discussions which have been carried on in the columns of the WORLD AND ENGINEER relative to the operation of compound-wound dynamos in multiple. I had some

experience in 1894-5 just along the lines discussed. We were operating a railway using four 100-kw compound-wound 550-volt generators, each belted to a separate engine. These generators were in charge of a non-expert—in fact, in the charge of a person who had been "broken in," never having had experience in the care of dynamos before.

On the switchboard there was a circuit breaker in the positive lead of each generator. The switches used were two single-pole switches on the switchboard (one for each lead) and an equalizer switch on each machine. When the plant was started we followed the then prevailing system of first closing the equalizer switch, and then the two-single-pole switches simultaneously. In case of overloads on the line, all the circuit breakers would blow out; consequently it was necessary each time to put the machines on the line one at a time.

I soon found that the operator was continually having trouble because of the failure of the generators to take their load properly. This trouble I at first attributed to the failure of the engines to govern, and this probably had something to do with it. We tried various combinations, including the schemes suggested by Mr. Mailloux in his letter appearing in your issue of Jan. 13, but contrary to his experience, I found that the only way in which we could avoid continual trouble and retain our non-expert attendant was to put in first the equalizer and positive switch, bring the generators to voltage, and lastly throw in the negative switch. This practice was continued, and doubtless is still in use, there having been no trouble in throwing the generators together after the method was adopted.

CLEVELAND, O. H. H. HOLDING.

To the Editors of Electrical World and Engineer:

Sirs:—I have been much interested in the various articles appearing in your recent issues relative to paralleling compound-wound generators, as I have operated both the older and newer methods referred to, and with units of varying sizes.

Advocates of the older methods—meaning by this, the triple-pole switch arrangement with its various modifications—would meet with more or less difficulty in carrying out their ideas in many of the more modern plants, owing to changes in station design affecting the position of the switchboard. In the older systems, whether used for lighting or railway purposes, the switchboard was located at a point as nearly equidistant from all the generators as possible, since the equalizer from each machine went direct to the switchboard. In the case of generators provided with a compounding shunt across the series field frequently an additional length of wire was used in the equalizer circuit between the machine and the switchboard, where one generator was nearer the switchboard than others, each generator requiring more or less resistance according to its distance from the switchboard.

Now, as a radical departure from this method, modern plants often have their switchboards quite a distance from the generators, no account being taken of an equidistant point from all the generators, the equalizer in this case making connection with a common terminal running to each machine, each machine, of course, being provided with a switch for disconnection. Thus it would be impossible in most modern plants to adopt the older method of bringing the equalizer to the board without making various alternations. As to the question of the drop in potential due to throwing in additional generators, the slight difference is hardly noticeable on a railway load, but in the case of a lighting load the conditions are changed.

I note in the letter of Mr. Mailloux the statement that he has found no satisfactory way of overcoming this drop, and in this connection I would refer to a previous suggestion made by me in these columns—that with the newer method the series windings of all the machines whether running or not, can readily remain in circuit. In this method the compounding is uniform on the mains regardless of the number of machines running. I knew of a small trolley road where the motorman could tell from the speed of his car whether one or two units were generating in the station, due to the fact that the series coils of only the machines generating were allowed to remain in circuit, the older method being employed. The machine being over-compounded 10 per cent., this gave the line a higher voltage when one machine was running at anywhere from one-half to full load, than when both units were operating under a considerably less load. As to the disadvantages of allowing the series winding to remain in circuit, I see none, compared to the beneficial results obtained.

In the letter of Prof. Anthony, in your issue of Jan. 20, the statement appears that machines to be used in parallel should never be over-compounded. This statement I cannot indorse. It would be manifestly impossible where economy is desirable, to operate but one generator to carry the entire load unless that load averaged the same every hour of the run, which condition is rarely, if ever, met with in practice, unless it be where a large storage battery is used in conjunction with the generator. Ordinarily in practice two or more generators are requisite. If machines operating in parallel are compounded for zero percentage loss in line, or "evenly" compounded, I would be pleased to get Prof. Anthony's idea of how he compensates for the loss unavoidable in the system.

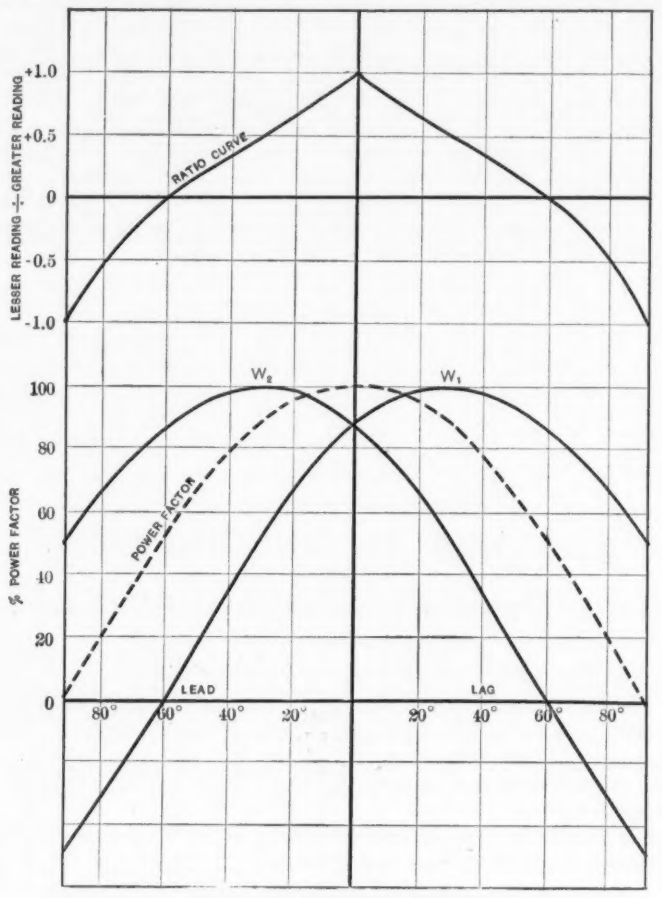
MILLERS FALLS, MASS. W. W. MASON, JR.

Power Factor Measurements.

To the Editors of Electrical World and Engineer:

Sirs:—The writer was greatly interested in the article on "Power Factor Measurements," published in your issue of Dec. 9, 1899, by Mr. Aug. J. Bowie, Jr. His solutions certainly possess a mathematical elegance and a refinement of analysis that are seldom attained.

Concerning the method of power factor measurement on three-phase circuits by the use of the ratio of wattmeter readings, the writer devised such a method in 1896 and published it in the *Wisconsin Engineer*, Vol. I., No. 1, the article being abstracted in the Digest of a contemporaneous number of the ELECTRICAL WORLD, and



POWER FACTOR MEASUREMENTS.

later incorporated in the work of the Professors Jackson on "Alternating Currents and Alternating Current Machinery." While the method of analysis was comparatively crude, some merit is claimed for the graphical treatment which is herein reproduced.

Connecting the wattmeters by the well-known two-wattmeter method, and using Mr. Bowie's notation, the equations

$$W_1 = V_1 I_1 \cos(30° - \beta),$$
$$W_2 = V_2 I_2 \cos(30° + \beta),$$

are plotted, $V_1 I_1$ being assumed equal to $V_2 I_2$, the condition of a balanced circuit. These two curves are sinusoids differing in phase by 60°. The ratio of the lesser reading to the greater is also plotted for different values of β, and for convenience a power factor curve (represented by the broken line) is now added to the original dia-

gram. The following conclusions can now be drawn from an inspection of the diagram:

1. When the angle of lag or lead is less than 60°, the sum of the wattmeter readings represents the power.

2. When the angle equals 60° one meter will read zero and the other the entire power of the circuit.

3. When greater than 60°, the difference of the readings represents the power.

4. When both instruments read alike, the circuit is either without reactance or is entirely wattless.

5. Given the ratio of the readings, it is now easy to determine the power factor and also the angle of lag or lead of the circuit, by reference to the curve of ratios—provided it is known whether the angle is greater or less than 60°. Judgment will indicate this in most commercial applications; but, should a doubt exist, vary the load (this usually changes the power factor) and if, as one meter reading approaches zero the indication of the other decreases, the phase difference is less than 60°; if it increases, the phase difference is greater than 60°.

This method is especially applicable to tests of induction motors and other special cases of a practically balanced load, and has been found to possess an accuracy slightly greater than the old method involving volt-ampere readings. Mr. Bowie's tabulation is purposely based on greatly exaggerated values of the higher harmonics, such as are not likely to occur in practice, and even this impartial view shows the method to be at least as accurate as are most wattmeters in daily use.

BUDD FRANKENFIELD.

CHICAGO, ILL.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE.

By CARL HERING.

DYNAMOS, MOTORS AND TRANSFORMERS.

REFERENCES.

Alternators in Parallel.—GOERGES.—Referring to the article of Benischke (Digest, Jan. 13) he claims that it is possible to calculate analytically all causes which produce the surging of alternators connected in parallel, with the same degree of exactness, as alternators may be predetermined. He gives a short outline of his theory and promises a fuller explanation. His concluding formula is nearly identical with that of Blondel (Digest, Dec. 9).—*Elek. Zeit.*, Jan. 4.

Alternators in Parallel Driven by Gas Engines.—DETTMAR.—A long French abstract of the German paper noticed in the Digest Nov. 11.—*L'Eclairage Elec.*, Dec. 30.

Short Circuit Curve of Alternators.—GOLDSCHMIDT.—A short reply to the criticism of Rothert (Digest, Jan. 13).—*Elek. Zeit.*, Jan. 4.

The Commutation of the Direct Current Dynamo.—The first part of an illustrated summary of eight important recent papers on this subject, all of which have been noticed in the Digest or in the ELEC. WORLD AND ENG.—*Lond. Elec. Rev.*, Jan. 12.

Armature Windings.—EMDE and OLSEN.—A highly mathematical discussion of the conditions of certain closed circuit, continuous current armature windings.—*L'Eclairage Elec.*, Dec. 2, 9.

Continuous Current Dynamos.—GUILBERT.—A continuation of his article (Digest, Nov. 4) giving brief, illustrated descriptions of recent improvements, taken from patent specifications.—*L'Eclairage Elec.*, Dec. 2.

LIGHTS AND LIGHTING.

Three Arc Lamps in Series.—An abstract of a communication of Gosselin made to the International Society of Electricians in Paris and of the discussion which followed on the advantages and disadvantages of the ordinary method of connecting two arcs in series with an adjustable resistance between 110-volt mains, as compared with the recent practice of connecting three arcs in series without resistance (Digest, Oct. 14, Nov. 18). While it appears that in the new method no energy is wasted in the resistance, this result is obtained only by diminishing the power consumed in each arc and by using very short arcs. With two arcs in series, the rheostat and the line consume about 22 volts, with three arcs, the line consumes about 2 volts; therefore, if the efficiency is the same, the increase of illumination is 21 per cent. As for three arcs, the arcs must be short and of smaller intensity, carbons of smaller diameter are to be used, which has a good effect on the efficiency. Aliamet questions the advantages of the new method. The external resistance is important for maintaining the constancy of light. In order to keep the voltage between three arcs high enough, it is necessary to use for the mains nearly three times the copper which is necessary in the ordinary practice. During the period of lighting, the current is very high, so that it is necessary to use a rheostat for starting. He claims that in order to obtain good results with three arcs, it is necessary to increase the voltage of the mains to 130 to 135 volts. Sartiaux says the only advantage of three arcs is that the manufacturer sells one lamp more in each case; generally one of the three is very bright and the other two dark. Hegner approves of three arcs in series. He claims that the quality of the carbons is very important, and that it is possible to obtain arcs of different lengths and of different voltage. In order to have a good illumination it is necessary to keep the arc constant by a proper adjustment.—*L'Eclairage Elec.*, Dec. 16.

POWER.

Individual Electric Motors.—A discussion of the question of how small a tool it pays to operate with an individual electric motor, held in the Am. Soc. Mech. Eng. Prof. Jackson says that all large tools or machines requiring from 5 to 7½-hp and over, should be provided with individual motors, while smaller tools or machines, requiring less power should be grouped and driven from a motor-driven shaft; these groups should ordinarily be arranged so that a motor of not less than from 3 to 5-hp capacity is required and not more than from 10 to 15-hp; each industry includes conditions of its own which must be taken into account. Mr. Smith says the question is a commercial one pure and simple. Mr. Halsey remarks that at the Baldwin Locomotive Works a rule forbids the use of motors of less than 5-hp under any circumstances.—*Transactions Am. Soc. Mech. Eng.*, Vol. 20, 1899.

Electric Cranes.—A continuation of the well illustrated description of recently installed English cranes (Digest, Dec. 9, 16). In connection with one of them a controller is used which is of the liquid resistance type, the electrodes being raised and lowered by a bar sliding in vertical guides, and actuated by the handle-bar. The latter is pivoted upon a plate fixed to the back of the reversing switch, and is guided by a curved plate. The slot in which the handle bar travels is so shaped that the handle can only be turned when the bar is in its topmost position, with the circuit broken at the surface of the liquid resistance, while the curved plate is nicked at intervals to receive a spring catch on the handle, giving definite steps of resistance. In this way it is impossible to cut off the current without leaving all the resistance in circuit, or to reverse the current without first switching off, while the direction in which the handle points shows which way the motor will run.—Lond. *Elec. Rev.*, Jan. 12.

Electricity in Mining.—Some notes on a method tried in Germany for bringing down coal. In the Clausthal mines an electrically-driven percussion rock drill was tried, but no conclusive opinion as to the practicability of the drill could be obtained, as in its present form it is both too long and too heavy. In the Olpe Arnsberg mining district electrically-driven percussion rock drills were used to advantage. With these drills equipped with a 1-hp motor running at 250 revolutions, holes can be sunk at the rate of 3½ in. per minute in the solid rock and to about 4¾ in. in a mixture of rock and schist.—*Kuhlow's Rev.*; noticed briefly in Lond. *Elec. Eng.*, Jan. 5.

Fuel Supply.—An editorial calling attention to the fact that the prices of coal in England have risen rapidly to a figure which must seriously affect the cost of production of electrical energy, and there are prospects of a further rise. The question of whether other adequate sources of fuel supply are available is discussed, and it is said to be practically certain that a prolonged or permanent reduction in

the supply of coal would place the industrial world at the mercy of petroleum yielding countries, as Russia and the United States. The question of the applicability of liquid fuel to electric power stations is referred to. With reasonable prices of coal, the cost of oil fuel for ordinary steam raising is said to be prohibitive. Under the present conditions, however, it is believed to be advisable for electric power station engineers to make suitable provision for the use of oil fuel as a stand-by, as this form of fuel might advantageously be adopted for a certain proportion of the boiler plant at all times, leaving the remainder of the boilers to be fired by coal under ordinary circumstances. But even these latter could easily be constructed so that the change from coal firing to oil firing could be effected quickly and cheaply. In this way the power station engineer could defy coal famines on the one hand and petroleum rings on the other.—Lond. *Elec.*, Jan. 12.

Utilization of Town Refuse.—KOLLER.—An article in which he calls attention to the great progress of the introduction in England of destructors for burning refuse. The system entails an outlay of from 8 to 25 cents per ton handled. The resulting ashes and clinker find a sale for industrial purposes, and the heat generated can be utilized for electric lighting, etc. In Berlin 1000 tons of rubbish are produced daily, and trials with the destructor furnaces demonstrated that 60 per cent. of this refuse remained unconsumed after treatment; the process had therefore to be abandoned. He also refers to the Wegener process, which aims at the destruction by heat of all organic and combustible substances and the melting of the entire residue at a temperature of 2000 C., and estimates that the Berlin refuse available per hour, treated on this system, will yield "2800-hp hourly" (presumably meaning 2800-hp continuously).—*Ann. fuer Gewerbe u. Bauwesen,* June 15. The Wegener furnace is described in an article by Haentzschel, *Gesundheits Ingenieur,* June 15. Both articles are abstracted in *Inst. Civ. Eng. Abstracts,* Vol. 138, part 4.

Refuse Destructors.—DE SEGUNDO.—An article on refuse destructors including some data. In referring to the paper of Russell (Digest, Jan. 6) he quotes the latter's statement that the cost of destruction is 60 cents per ton, and that this is less than that at which the refuse could be barged away in London. The author says that at least one Vestry has found it cheaper to barge away refuse than to burn it. The subject is one upon which no comprehensive and reliable data have yet been collected.—Lond. *Elec. Rev.*, Jan. 12.

Gas Driven Electric Plant.—A note on a test made in a small plant in France consisting of a 65-hp Crossley gas engine making 210 revolutions, the guaranteed consumption of which under full load being between 18.7 and 20 cb. ft. per hp-hour. It was run for one hour at 160 amperes and 250 volts, during which time it consumed 1165 cu. ft. This corresponds to 0.0289 kw-hours per cu. ft., the guarantee being 0.03. (In the note the word "watts" is used for "watt-hours" in one place and in two others for "kw-hours;" as this is a self-evident mistake it has been corrected here).—*Prog. Age,* Jan. 15.

REFERENCES.

South Wales Power Distribution.—Two articles with a map, on an extended power distribution scheme. Three generating stations are projected and railway lines will be used as the general route of its distributing mains. Any one who undertakes to take 20,000-kw hours per year will be considered as a wholesale consumer. The maximum prices are to vary from 8 cents per kw-hour for an intermittent supply to 4 cents per kw-hour for a regular load. No technical data are given.—Lond. *Elec. Eng.*, Jan. 5 and 12.

Electrically Operated Machine Shop.—An illustrated description of the electric installation in the Caldwell machine shops in Chicago. A 220-volt direct-current system is used to supply the motors in the machine shop, an electric crane, besides the arc and incandescent lamps.—*West. Elec.*, Jan. 20.

Condensers in Alternate Current Power Transmission.—LOMBARDI.—A very long French abstract of the Italian paper noticed in the Digest Nov. 4.—*L'Eclairage Elec.*, Dec. 30.

TRACTION.

Electric Railway Statistics for Germany.—The annual table of statistics of electric railways in Germany, comprising 14 full pages of tables, with well filled columns of information. This table refers only to public railways and not to private lines, for the period from Sept. 1, 1898, to Sept. 1, 1899, i. e., for one year since the last statistics (Digest, Jan. 28, 1899) were published. The table of the installed public tramways is complete; the second part, giving a list of public tramways under construction or projected is not complete. The number of cities with electric traction was 3 in 1891, 33 in 1895, 77 in 1898, 89 in 1899. The whole length of lines in September, 1899, was 1270 miles, the whole length of tracks 1744 miles, the number of motor cars, 4504, of trailers 3138; under construction or decided upon are 666 more miles of lines with 892 miles of tracks. The traction machines installed aggregated 52,509-kw, against 33,333-kw in 1898; the accumulators installed for traction amount to 13,532-kw, against 5118-kw in 1898. The machines and accumulators for traction and for lighting together, in Germany, aggregated 234,360-kw in September, 1899. The average kw per mile of track was 32.8 in 1899, against 33.1 in 1898, and 34.7 in 1897; the average kw per motor car was 14.3 in 1899, against 14.2 in 1898, and 14.6 in 1897; it is somewhat surprising that the values are so nearly constant. In most cases the trolley system is used, in a few cities for short distances the conduit system, in a few more cases the plain accumulator system. The combined trolley and accumulator system has been introduced more frequently than heretofore. The voltage of supply is generally from 500 to 550, only in a few cases 650, 600, 450, 300. Two lines under construction in Berlin will be operated at 750 volts. —*Elek. Zeit.*, Jan. 4.

Saving at the Controller.—CRAVATH.—An article of a general nature giving rules for motormen. Any real saving in power by proper controller handling, must be made without interfering with the schedule. The economy of controller handling depends mainly on the way he gets his car up to speed and on the way he utilizes the momentum of the car to propel it after it is up to speed; this should be used as far as possible by drifting with the current off. The car should never be run up to a high speed, when a slower one would do just as well. The brakes should be used as little as possible; but when they are used, it should not be done in a dilatory way. During the start the controller should be advanced neither too slowly nor too rapidly; in the case of most light cars in crowded city service, about one second is the right time to each notch. He thinks it would be a good thing to regulate the rate of acceleration automatically and take it out of the motorman's hands entirely.—*St. R'y Rev.*, January.

REFERENCES.

Como.—PODOSKI.—A long, well illustrated description of this short electric tramway. The trolley system is used; a feature of interest is the overhead installation which has been constructed with a special view to being as inconspicuous as possible, for aesthetical reasons. A slight modification of the electromagnetic rail brake devised by Schiemann (Digest, Aug. 19) is used.—*Elek. Zeit.*, Jan. 4.

Sheffield Tramways.—An illustrated description of this English trolley line which has already been referred to in the Digest, Sept. 23.—*St. R'y Rev.*, January.

Interurban Electric Railway.—An illustrated description of the Detroit, Ypsilanti & Ann Arbor trolley line, the length of the track of which is 50 miles.—*St. R'y Rev.*, January.

Electric Traction.—S. P. THOMPSON.—An extract of those parts of his presidential address on electric progress (Digest, Dec. 16, 23) which relates to electric traction.—*St. R'y Rev.*, January.

Tramway Fittings.—Illustrations, with short description of some English fittings which are claimed to be improvements on American practice. They include long and heavy ears with a well channeled groove for the wire, the W. R. turnout, and a carshed frog.—*Lightning,* Jan. 4.

Conduit System.—A very long, well illustrated description of the conduit system with side slot, used in Paris, as noticed in the Digest Jan. 20.—Lond. *Elec.*, Jan. 12.

Electric Canal Boat Towing.—An illustrated description of the Koettgen system, referred to in the Digest July 22 and Sept. 2.—*Sc. Amer. Sup.*, Jan. 27.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Central Stations of the United Kingdom.—The large annual table with many columns of information. Some of the results are summarized in an article on lamp connection diagrams; but the increasing number of combined lighting and traction plants renders motor load an important factor. The first diagram shows the continued growth of the lamp connections of the different companies in London from 1891 to 1899; the second diagram the increase in connections year by year in London and the provinces. The total in the United Kingdom is now an equivalent of 6,869,000 lamps of 8-cp, an increase of nearly one and a half million over last year, the increase during 1898 having been one and a quarter million. The third diagram shows the lamp connections to continuous and alternating cur-

rent stations in the provinces and London: in the provinces the continuous current supply is in the lead; the alternating current supply is about three-fourths as much, while the combined continuous and alternating current system is about the half of the plain alternating current supply. In London the continuous current supply is also in the lead, while the combined continuous and alternating current supply is nearly equal to it and more than twice as large as the plain alternating current supply. The fourth diagram shows the municipal and company lamp connections. In the provinces the municipal supply is about five times the company supply; in London the company supply is eight times the municipal supply; the total municipal lamp connections in the United Kingdom exceed those of the companiesthe figures being 3,798,000 and 3,071,000 respectively.—Lond. *Elec.*, Jan. 5.

Multiphase Plant in Conjunction With Continuous Current Systems.—An abstract of an informal discussion at the English Northern Society, on the difficulties accompanying the use of multiphase machinery in conjunction with a continuous current system of supply. Ferranti referred to the Glasgow tramway scheme, where the cost of the controlling and transforming apparatus amounted to more than three times the cost of the generators, apart from the cost of the buildings and the items of attendance, maintenance and depreciation. The object in view was to save the cost of heavy feeders and the increased loss due to voltage drop in these feeders. He does not indorse the scheme; the alternative was to adopt either continuous current throughout, or single-phase alternating. The latter involved the use of single-phase alternating current motors on the cars, which he believes feasible on account of the improvements made in the last years. Nesbitt also said the adoption of the multiphase system at Glasgow was a mistake; he estimated that the extra cost of cables of sufficient capacity for continuous currents at Glasgow would have amounted to very little more than the cost of the transformers. Mountain considers the single-phase system to be commercially better than the multiphase.—*Lightning*, Jan. 4.

REFERENCES.

Central Stations in England.—A long statistical article with three large tables and several diagrams showing the various items of costs and output in the years 1896, 1897, 1898. The plants owned by municipalities and those owned by companies are treated separately. The information is very complete, but chiefly of local interest.—Lond. *Elec.*, Jan. 5.

Milan.—HOSPITALIER.—The conclusion of his long illustrated article (Digest, Nov. 25, Jan. 13) describing the Porta Volta and the Santa Radegonda substations.—*L'Ind. Elec.*, Dec. 25.

Steamship Oceanic.—An illustrated description of the electric installation on the steamship Oceanic which was referred to in the Digest Nov. 11.—Lond. *Elec.*, Jan. 5; reprinted without illustrations in *El'ty*, Jan. 24.

Synchronizing Alternators.—RITTER.—A long illustrated article describing several devices for synchronizing alternators, which he calls phase inductors. The principle of all of them is exactly the same as that of the method of Mueller, described in the Digest July 8, but he starts from a more general point of view in his explanations and gives a full outline of various applications of the principle, which are well illustrated by diagrams.—*Elek. Zeit.*, Jan. 4.

Development of Constant Current Arc Lighting.—BIEBEL.—A paper read before the Chicago Electric Association, discussing chiefly some general features in the design of modern constant current generators.—*Elec. Rev.*, Jan. 17.

WIRES, WIRING AND CONDUITS.

Disposition of Three-Phase Transmission Lines.—BOWIE.—An article in which he calls attention to the fact that in many alternating current systems the proper arrangement of the wires on the poles, relatively to each other, becomes a matter of great importance, as a bad arrangement may lead to serious interference with the regulation of the systems, raising the pressure in some circuits and dropping it in others, far out of proportion to the loads. The common remedy is to spiral the wires, but he believes that spiraling should be avoided as much as possible, as it not only introduces complications, but is also more or less of a source of danger. The idea of spiraling is to obtain equal induction in all the circuit and no mutual induction between circuits; if in a transmission line the wires are at the corners of an equilateral triangle, spiraling is necessary only to avoid mutual inductance. It is, however, often inconvenient to place the wires in the form of a triangle, and hence it is important to know how great the effect of unequal inductance will be, so as to know whether it is worth while to spiral the lines. He considers the general case, that the voltage triangle at the start and the currents and their phase relations are known, and develops a graphical method to determine the potential of the receiving end relatively to the transmitting end for each wire. He then considers the special case of a balanced load and treats the problem graphically to find what must be the voltage triangle delivered to the lines at the station in order to deliver a given equilateral voltage triangle at the end of the line, if the wires are placed on the same cross arm, so that the distances between the first and second and between the second and third are equal. From the graphical solution he finds the algebraic expressions for the length of the sides of the voltage triangle in the station. He shows that this is not an equilateral triangle; of the two outside wires the one which leads the centre wire drops more than the one which lags behind it. Conversely, if an equilateral voltage triangle is delivered to the line at the station, the voltage received at the end of the line is not an equilateral triangle with a balanced load. However, if the load consists to any extent of motors, they act as equalizers, the legs receiving the higher voltages taking more current, and this reacts on the lines. It is well, however, not to rely on motors for such purposes, since aside from other considerations the motors are not working at the best efficiency under such circumstances. In some experiments made by him with 11 per cent. difference of voltage between two of the phases, there was as much as 60 per cent. difference in the current taken by different legs of a three-phase motor, which is excessive and should never occur in practice. He then discusses the case that the lines are spiraled, running for a third of the distance *A B C*, for the next third *B C A*, for the last third *C A B*; then the drops in each of the feeders are alike; but the effective distance between the wires as regards inductance is increased to 1.26 the value for the arrangement of the wires in an equilateral triangle, for a given minimum distance between wires. It is possible in transmission lines to spiral three wires arranged on one cross-arm by the use of only one pole with two-cross-arms, though a much better plan it to use two poles with two arms each, which is illustrated. Where it is only a question of avoiding unequal self-induction and not of avoiding mutual induction, the wires may be spiraled thus: *A B C, A C B, C A B*, so that each wire occupies the centre position for one-third of the distance. Four numerical examples are given to show the effects of unequal self-induction caused by not spiraling the wires. Only in very long lines at very high voltages, the capacity effect becomes important as affecting the inequality of the three voltages. To overcome practically all such inequality, a three-phase circuit with three wires on the same arm may be spiraled as follows: *A B C* one-sixth of the line, *B C A* the next sixth, *C A B* one-third, *B C A* one-sixth, and *A B C* the last sixth.—*Jour. of Elec.*, November.

Wiring with Uninsulated Return.—BATHURST.—A communication referring to the method of wiring used in Bonn (Digest, Jan. 6 and 20). He says that Bonn is by no means the first continental town to use a continuously earthed bare middle or insulated return. In Bonn and in five or six other continental towns it is common practice in house wiring, to run one insulated conductor, 300 meg. quality, inside a plain or brass armored insulating conduit as the outer, and have for the return a perfectly bare copper wire of equal carrying capacity, stapled on the wall or plaster, either behind or by the side of the insulating tube; it is quite usual in passages and corridors, while in the rooms the practice of stretching flexible cord on poreclain insulators is followed.—Lond. *Elec.*, Jan. 5.

YORKE.—A communication referring favorably to the above letter of Bathurst. The method used in Bonn is said to be used for economical reasons only, for since the bare return is run separately from the insulated lead in the metallic pipe, there is not much gain, if any, in safety, which can only be secured by combining the insulated lead and bare return under one metallic covering.—Lond. *Elec.*, Jan. 12.

Rubber Insulated Wire in Steel Conduits.—ZINGLER.—An article in which he calls attention to the perishability of vulcanized rubber, which is said to be admitted generally. As long as wood casing only is used, no inconvenience is caused by the deterioration of the rubber, but if the wires are drawn in steel conduits, it is subjected to alterations, followed by breakdowns. He does not blame the steel conduit, which well serves the purpose of protection, but claims that the covering of the wires in it constitutes a real danger which is only potential in the case of wood casing. Another important point is that of joints; if they are to be avoided with steel conduit, the cost of wiring is largely increased, so that on account of cheapness, joints should be used if it is possible to get rid of their weakness.

The pure rubber joint, which if well made is quite safe in wood casing, should not be used with steel conduits, such practice being dangerous with 100 volts supply and doubly so at 200 volts. The fewer joints the better, and those few should be vulcanized. Mechanical joints have not yet received much attention, but he thinks the matter is capable of development; they would lead to the cheapest form of wiring. Apart from the question whether they may or may not be a more permanent insulating material than rubber, even if it is not such a good insulator, he urges strongly that only the highest grade of rubber cables should be used, the wires being insulated with pure and vulcanized rubber, the latter to have the sulphur assimilated with it most carefully; the pure rubber, at any rate, serves to prevent the sulphur attacking the copper, which is one of the most frequent causes of the rotting of cables in the presence of moisture.—Lond. *Elec. Rev.*, Jan. 5.

Wiring for Decorative Lighting.—May.—A paper read before the Electrotechnical Society of Frankfurt, in which he points out the great danger of fire from careless wiring for decorative lighting. Every such installation, even if temporary only, should be examined, before used, by an engineer of the plant furnishing the current. The wires should be enclosed in pipes, best in paper pipes. In the discussion which followed the proposal was made to forbid decorative lighting with flexible wiring at all.—*Elek. Anz.*, Dec. 14.

REFERENCES.

Resistance of Cylindrical Conductors to Alternating Currents.—E. H.—A short article describing a method, devised by Potier, for calculating the ratio of the resistances to alternating and to continuous currents by means of simple formulas containing only values which can be measured directly. A translation in full will be printed in a following issue. The formulas show that the increase of resistance to alternating currents is independent of the nature of the wire if the different lines to be compared have the same linear resistance. —*L'Ind. Elec.*, Dec. 25.

Cement Conduits.—Illustrations of the large cement conduits which are now being laid by an English telephone company for their underground interexchange cables, and are said to have proved satisfactory. Some instructions for laying and jointing, issued by the company, are reprinted.—Lond. *Elec.*, Jan. 5.

Electro-Physics and Magnetism.

Cathode Radiation.—Wiechert.—An illustrated account of an experimental investigation by which he found the ratio of the charge and the mass of a cathode particle to be 12,600,000 c. g. s. units (Simon's value is 18,650,000; Digest, Dec. 23). He uses this result to determine what amount of matter is transported with each electron, or the "mass of an electron," and finds it to be the "1/1300th part of the atomic weight of oxygen." He indorses the corpuscular theory of electric conduction, believing that electricity is a form of matter which links the atom to the surrounding ether, but can be transferred from one atom to another. He favors the idea that there is only one type of electron, and that it is the negative one; this would seem to be a modern variation of the old one-fluid theory.—*Wied. Ann.*, No. 12; abstracted in Lond. *Elec.*, Jan. 12.

Printing by Röntgen Rays.—Le Roux.—An article on the Izambard method, which has already been noticed in the Digest. In order to obtain black letters on light ground, the original writing or print is made with a non-metallic ink which has the property to resist fatty ink and the whole paper is then covered with a fatty metallic ink which adheres to all parts except on the letters. The application of this method for secret letters and for artistic designs is discussed and some notes are given as to priority of the invention. All the details of the method are said to have been improved recently and that the method will be exhibited at the Exposition in Paris.—*L'Elec.*, Dec. 16.

Röntgen Rays.—Rollins.—A continuation of his illustrated serial. When a tube has become useless, he recommends filling it with illuminating gas until the hydrogen has combined with the terminals, and then to repump. He tries to explain the appearances of perforated terminals in vacuum tubes. He made cathodes of most of the common metals and found hydrogen in most of them; in zinc it is so abundant that this metal makes a good cathode, so far as the production of Röntgen rays is concerned. He adds some remarks concerning the reduction of the cost of Röntgen tubes. He discusses mercury cathodes; and the free electron and other ether theories of cathode rays.—*Elec. Rev.*, Jan. 10 and 17.

Rarefied Gases.—Bouty.—A French Physical Society paper, describing some experiments, from which he concludes that rarefied gases have no electrolytic conductivity, which is in agreement with Wiedemann's results and in opposition to those of J. J. Thomson.—*L'Ind. Elec.*, Dec. 25.

REFERENCES.

Contact Electricity.—Spiers.—The English Physical Society paper in full with illustrations, an abstract of which was noticed in the Digest Dec. 9.—*Phil. Mag.*, January.

Electrostatic Rotation.—Dell.—Descriptions of some additional experiments (see Digest Jan. 13).—*Elec. Rev.*, Jan. 17.

Physics.—Trowbridge.—An article of a general nature on recent advance in physical science, especially in the investigation of Röntgen rays.—*Int. Monthly*, January; *El'ty*, Jan. 24.

Magnetic Properties of Alloys.—Richardson.—The English Physical Society paper in full with illustrations, an abstract of which was noticed in the Digest Nov. 25.—*Phil. Mag.*, January.

Electro-Chemistry and Batteries.

Electrochemical and Electrometallurgical Industries.—Kershaw. —A continuation of his article noticed in the Digest Jan. 27. There are now nine electrolytic chlorate of potash plants in operation in America and Europe, over 33,000-hp being available; they could supply the whole world's demand for this chemical, but he doubts whether their present output exceeds 6000 tons, or about two-thirds of the annual production of chlorates. During 1899 the selling price of chlorates has been maintained fairly steady. He calls attention to an important suggestion made by Mueller, who has discovered that the addition of a small amount of a soluble chromate to the electrolyte greatly facilitates the formation of chlorate, and also enables a much higher current efficiency to be maintained; it is said to be probable that in time all electrolytic chlorate plants will adopt this method of working. The number of electrolytic copper refineries is 42, the total output being estimated at 200,000 tons per year. As the aggregate copper output of the world in 1897 was 397,000 tons and 434,000 tons in 1898, about 50 per cent. of the world's supply of copper is now electrolytically refined. The extraction of copper from its ores by leaching and by electrolysis of the resultant solutions, has attracted large attention, the difficulties being due to the presence of impurities in the solutions obtained, and to the effect of these upon the quality of the deposited copper; the Hoepfner process is now in use on an industrial scale in a German plant. The use of solutions of hypochlorite of soda prepared by electrolysis, for bleaching cellulose and cotton goods, is slowly extending in Germany, France and Russia. All processes for electrolytic production of hypochlorites are based upon the electrolysis of a solution of common salt with insoluble electrodes, at a low temperature and without a diaphragm; the Kellner, Vogelsang, Corbin and Stephanow cells are in practical use. The adoption of the Woolf process for the production of a disinfecting solution from sea water by electrolysis in Havana (Elec. World and Eng., Oct. 7) is referred to. It is remarked that it is not quite clear why the Woolf process should be a success in America, when the Hermite disinfecting process has failed in Europe; but the higher cost of bleaching powder and all chemicals in U. S. A. has had some influence upon the result. Attention is called to the researches of Foerster and Jorre, who found that the conversion of hypochlorite into chlorate is caused by other conditions than heat, and that the presence of free hypochlorous acid is one of these; also to the investigation of Muspratt and Smith of the limits of concentration for hypochlorite solutions. They succeeded in obtaining liquids containing 500 gr. free Cl per liter, though not by electrolytic methods, and found that two of the chief hindrances to the production of such solutions are the presence of ferric oxide and of carbonic acid as impurities in the original salt solution.—Lond. *Elec. Rev.*, Jan. 12.

REFERENCES.

Aluminum.—Henderson.—An abstract of the article noticed in the Digest Jan. 6.—*Elec. Rev.*, Jan. 17.

Purification of Water by Ozone.—Andreoli.—An article in which he makes some remarks as to Otto's system and refers briefly to his own investigations.—*L'Elec.*, Dec. 23, 30.

Speed of Electric Reactions.—Cohen.—A long French abstract of the German Electrochemical Society paper noticed in the Digest Sept. 2.—*L'Eclairage Elec.*, Dec. 23.

Calculation of the E. M. F. of Cells.—Tommasi.—An English translation of the French article noticed in the Digest Nov. 25.—Lond. *Elec. Rev.*, Dec. 29.

Contact vs. Chemical Theory.—A long illustrated summary of the

explanation of the Volta effect by both these theories, with special consideration of the theories of Lord Kelvin and Lodge.—Lond. *Elec. Rev.*, Dec. 29.

Electrochemical Laboratory.—LARGIADER.—A description of the electrochemical laboratory of the Technical High School of Zurich. —*Schweiz. Bauzeit.*, v. 34, p. 181; a French abstract in *L'Eclairage Elec.*, Dec. 23.

Electrolytic Laboratory at Stolberg.—NISSENSON.—An illustrated French abstract of the German article noticed in the Digest Oct. 28. —*L'Eclairage Elec.*, Dec. 23.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Electric Units.—FLEMING.—A continuation of the article noticed in the Digest Jan. 20. In a table he gives the names of the proposed new practical units and their equivalents in the present system of practical units and in the system of c. g. s. electromagnetic units. The "new ampere" = 10-amp., the "new coulomb" = 10 coulomb, and the "line" or line of force, all have the equivalent 1 in the c. g. s. system; the volt, the "new ohm" or deciohm, the "new henry" or decihenry, the "new watt" or 10 watts, and the "new joule" or 10 joules, all have the equivalent 10^8; the "new farad" or 10 farad has the equivalent 10^{-8}; the "gauss" or 1 dekampere-turn and the new unit of magnetic force or 1 dekampere-turn per cm, have the equivalent 4π in the c. g. s. system. He proposes to insert the word "new" in each case before the name of the new unit, and afterward discarding it. He points out that the new ampere, the new watt, the new joule and the new ohm, would be more convenient in practice than the present units. The only new unit inconveniently large is the new farad, and he proposes to call a hundred-millionth of the proposed new farad, or 0.1 of the present microfarad, a faradet. The new values of permeability of iron and other metals would be 4π times larger than the present values for the same values of induction. The adoption of the new system would involve no expensive changes in readjustment or remarking of measuring instruments, as in the ammeters, resistance coils, wattmeters, joulemeters, only the decimal point is to be changed. The voltmeters require no change at all. Tables and curves of permeability and magnetism curves will require to be altered by multiplying all permeability values by 4π and dividing the values representing magnetic or magnetizing forces in c. g. s. units by 4π. Hence 1 c. g. s. unit of magnetic force becomes nearly 0.08 of a unit in the new reckoning. Good wrought iron will have a permeability of 24,000 to 36,000 and the permeability of air will be 12.566. In order to show the advantages to be obtained by adopting this reform, he considers some special cases. First, the case of an iron ring wound with primary and secondary coils without or with air-gaps, which is the typical dynamo or transformer. Then we have the simple equation $\Sigma(A\ T) = \Sigma(F\ R)$ in which $A\ T$ stands for ampere-turns, F for total flux, and R for the reluctance of each part of the circuit. This equation is simply a statement of the additive property of m. m. f., viz., that the sum of all the m. m. fs. acting on the circuit is equal to the sum of all the products of total flux and reluctance in and of the separate parts of the circuit. He also considers the case of a very long iron bar magnetized in an endless solenoid; then the strength of the pole is numerically equal to the flux proceeding from it, and the pole strength is numerically equal to the product of the section of the magnet and its magnetization. If the section of the solenoid and the iron are the same, the total flux B through the iron must be that due to its intrinsic magnetization $\mathfrak{J}$ added to that which would exist in the same space if the iron were not there, B_0, or $B = B_0 + \mathfrak{J}$, which is an expression of the fact that there is an additive property in the physical states of the space before and after the iron is placed in the solenoid, in regard to the effect produced on an embracing secondary circuit when that state is annulled. If μ is the permeability of the core and K the susceptibility of the metal, then $\mu = 4\pi + K$, which means that the numerical value of the permeability of the space or ether, added to that of the susceptibility of the metal, is the value of the resultant permeability. The corresponding equations with the old units are physically uninterpretable.—Lond. *Elec.*, Jan. 5.

Photographing Current Curves.—WEHNELT and DONATH.—A description of a method of using Braun's cathode ray tube (Digest, Sept. 16) for photographically plotting a current wave. The cathode beam in the tube is deflected by an electromagnet excited by the current under investigation. The spot of light on the fluorescent screen is photographed on a sliding plate and side by side with it, the sinusoidal curve of a vibrating tuning fork; the latter is accomplished by attaching an aluminum foil with a pinhole to the prong, in the path of a strong beam of light. Some of the curves reproduced show the course of the current from a Wehnelt interrupter under various conditions of capacity and inductance in the circuit.—*Wied. Ann.*, No. 12; abstracted in Lond. *Elec.*, Dec. 29. (This abstract is the one which was referred to in another abstract in the Digest last week; by an oversight it was not published in that issue.)

Photographic Current Curves.—ZENNECK.—Another method of obtaining current curves by means of Braun's cathode tube. He produces curves on the fluorescent screen in the tube itself, where they appear absolutely steady and immovable as long as the current does not change. This is accomplished by using two deflecting magnets, one for producing the vibration of the spot of light in the ordinary way, and the other for imparting to it an additional lateral movement strictly proportional to the time. The latter is excited by a current taken from the circumference of a wheel carrying a thin wire and coupled to the alternator; the deflecting current is inversely proportional to the length of the wire in circuit at any instant. The only limit of the method is that of the speed of alternation which may be too great for photography; he puts this limit at about 1000 reversals per second. Several improvements in the construction of the Braun tube are described.—*Wied. Ann.*, No. 12; abstracted in Lond. *Elec.*, Jan. 12.

REFERENCE.

Registering Galvanometer.—GOISOT.—An illustrated article on the registering galvanometer, devised by Callendar. The mechanism is briefly described and illustrated, as also its application for registering the variations of the resistance of a conductor, by the use of the Wheatstone bridge arrangement, so that it may be used as a registering thermometer based on the variations of the resistance of a platinum wire.—*L'Eclairage Elec.*, Dec. 30.

TELEGRAPHY, TELEPHONY AND SIGNALS.

Wireless Telegraphy.—A short note on the difficulties which are said to be experienced in sending wireless telegraph messages between certain of the English camps in the war in South Africa. The hypothesis that the trouble is due to the presence of ironstone hills, is discredited by Marconi; he thinks the trouble may be due to the imperfect earth afforded by the dry soil and substrata.—Lond. *Elec.*, Jan. 5.

MISCELLANEOUS.

England in 1899.—An editorial on electric progress in England during 1899. There was a large increase both in the area in which electric light and power is now supplied, and in the lamp density of the supply where it is no novelty. The municipalizating movement is as strong, if not stronger than ever in the provinces, and the same tendency is apparent in London. The British manufacturers are still unable to keep pace with the demand for the machinery, and the consequence is that a quantity of electrical machinery is being ordered from abroad. The 200-volt lamp is gradually superseding the one for lower pressures, and its manufacture is now well past its experimental state. There is a growing tendency to combine lighting and traction undertakings, and it is not confined to municipalities. Two and three-phase systems are coming to the front for bulk supply schemes, while for distribution single-phase is giving place to continuous current. The large network of underground electric railways in London is getting nearer to completion, while electric traction on ordinary roads has made little progress. The progress in telegraphy and telephony, and electric science is also referred to.—Lond. *Elec.*, Jan. 5.

Patents Expiring in 1900.—A list of British patents of interest to electrical engineers which will expire during the present year. Also some editorial notes, in which it is said that none of these is likely to have any serious consequence on electrical industry in general. The list contains a patent of Tesla for an arrangement of a third brush and even additional brushes to a dynamo for the purpose of efficient regulation; a patent of Elihu Thomson for a process of electric welding by "pressing against each other the pieces or parts to be united and passing an electric current through the same;" and a Welsbach patent for the use of oxides of certain rare metals for incandescent gas mantles.—Lond. *Elec.*, Jan. 5.

Electric Drying Ovens.—RICHARDS.—A description of a safe and satisfactory drying oven for laboratory work, consisting of one large bottomless beaker inside another, both resting upon a tile, which is supported upon layers of asbestos and wire gauze. An inverted clock glass or porcelain dish serves as a cover. The source of heat is 5 m. of platinum wire, 0.22 mm. in diameter, wound upon a reel of glass rods and porcelain bars; a current of 2 amp. at 52 volts heats the oven to 140° above the temperature of the room. To equalize the temperature within the oven "a face" is placed immedi-

ately above the heating coil.—*Am. Chem. Jour.* 22, p. 45; abstracted in *Tech. Quart.*, December.

New Books.

KINEMATICS OF MACHINERY. A Brief Treatise on Constrained Motions of Machine Elements. By John H. Barr. New York: John Wiley & Sons. 8vo. 247 pages, 213 illustrations. Price, cloth, $2.50.

This book, which is the outgrowth of an earlier and smaller work on the same subject, represents the experience of a considerable number of years in giving instruction in the subject of kinematics to students in technical engineering classes. The purpose of the volume is to present in a condensed form those principles and methods which are deemed of most importance in a general course on kinematics, having in view the leading features of the modern trend of advancement in the industrial and engineering world. The book is moderate in size and deals briefly with many parts of the general subject, especially such as are more extensively dealt with in special treatises, or such as are of relatively less importance to the student of modern engineering design. Thus the part relating to toothed gearing is much abridged, but this subject has been quite extensively treated in numerous available works. On the other hand, the discussions of the applications of such important conceptions as instantaneous centres, velocity diagrams, etc., are rather fuller than are found in many of the shorter works on mechanism.

In carrying out the ideal thus set before himself, the author seems to have been signally successful in presenting with sufficient detail the important feature of the subject, and of treating more suggestively the various parts of less immediate importance. The style of the author is clear and the development of the subject is logical and continuous. While higher mathematics is used but sparingly, the student will need to be acquainted with trigonometry and analytical geometry in order to properly follow the development of the subject, and in particular the chapter on linkwork, instantaneous centres, etc.

The author's wide experience with practical engineering questions has enabled him to keep the treatment of the subject close to the live questions in the field, and to use illustrations drawn from the modern practical problems which are arising in the subject. The illustrations are numerous, specially prepared with but few exceptions, and carefully drawn and executed. The book is printed and bound in the standard style of the publishers, and may be cordially recommended to those interested in the subject of kinematics, and wishing in moderate compass a carefully planned and well executed presentation which has stood in the classroom the test of experience for a series of years previous to its publication in the present form.

THE ELEMENTS OF ALTERNATING CURRENTS. By W. S. Franklin and R. B. Williamson. New York: The Macmillan Company. 212 pages, 186 illustrations. Price, $1.75.

The prevalent use of alternate currents for transmission and for miscellaneous power work in the industrial arts has made a great demand for a suitable work on the subject. Every layman, and a good many students and technically educated engineers as well, look with interest now upon every new treatise. The general criticism of every such a work is that it contains too much mathematics. The average person has not studied the calculus and the student has either forgotten it or is disinclined to follow the deductions.

The other extreme is to give a so-called "popular" treatment which, so far as the writer has observed, is usually so weak a work as to be of little value to the practical man. We are yet to get a satisfactory work which meets the situation.

Messrs. Franklin and Williamson have presented an attractive textbook. As one takes up this to review he is pleased with the type, the subjects treated, the table of contents and the good index. The text is, on the whole, clear, and there is not too much mathematics, and where there is an analysis there is usually a graphical illustration, an analogue or a straightforward problem accompanying the equations.

Upon careful study, however, one finds that the book lacks two essentials—continuity and completeness. It savors too much of a miscellaneous collection of notes, more or less interesting and true, of course, and put together without sequence. The opening chapter gives fundamental definitions of flux, inductance capacity, etc., and is followed by the discussion of the alternator. There is interposed a chapter on instruments. This, however, just gives names and connections and assumes that the theory is previously understood.

Then one is taken back to "fundamentals" again—harmonic, electromotive force and current. This is rather involved and rather short. This could well be enlarged, as it is one of the most important chapters. This is followed by the treatment of resistance, inductance, capacity and resonance; then comes Steinmetz's method of treating complex quantities. Then one is led back to "fundamentals" again.

The succeeding chapter on single and polyphase alternators is content with stating the kinds, how wound, and tables of constants. Rotating field types do not appear to be presented. Then comes a chapter giving more or less important characteristics of transformers. This is followed by synchronous motors, rotary converters and induction motors. These latter and the final chapter on transmission lines are very disappointing, as they do not give any practical instructions regarding operating the same.

In the preface one is advised that the book is the result of seven years' teaching, and has withstood the test of the classroom. This may be true, but it is also true that to make it acceptable as a textbook it should be rearranged and many portions more fully treated where now the instructor must be understood to have given an oral explanation.

STANDARD POLYPHASE APPARATUS AND SYSTEMS. By Maurice A. Oudin, M. S. New York: D. Van Nostrand Company. 249 pages, 159 illustrations. Price, $3.00.

This volume is a welcome addition to the meager and insufficient literature of an important subject. It is in substance a notebook of present apparatus and methods putting on record a large amount of useful information heretofore scattered through periodicals or held by a few well posted engineers. There is in it little of theory and little of detail, but rather a well ordered general assembly of facts. Polyphase working gives so great facility for fineness in design and operation that the detail is almost endless, and unless cut short would soon expand a handbook into a treatise.

To the engineer and station manager the chapters on synchronous and induction motors and rotary converters are perhaps the most valuable and suggestive, and the data given in them will repay careful study. It is a pity, by the way, that the author did not forget to use those needless terms "rotor" and "stator." Unless they are to replace armature and field entirely in the electrical vocabulary they have no possible excuse for being, particularly as induction motors are now nearly always built with the field, or primary, stationary. If the present epidemic of word coinage does not soon cease one may as well take to ideographs and be done with it. Now and then one must charge up minor sins of omission against Mr. Oudin. For example, in dealing with the question of starting induction motors the impression is left on the casual reader that motors having a short circuited armature and started at reduced voltage will stand a far heavier overload than those designed to start with a resistance in the armature, the latter having a true polyphase winding. The real fact is merely hinted at, at the bottom of p. 77, i. e., that this difference is due merely to different design of the fields. This is making a virtue of necessity with a vengeance! Incidentally it would have been well to note that these short-circuited armatures are accompanied, if the power factor of the motor is decent, by abnormally small clearance which may be the source of considerable annoyance.

In treating of the starting of synchronous motors it would have been desirable to rub in well the fact that unless such motors are specially designed to start as induction motors, they will inevitably queer the general voltage of the system. No ordinary commercial machine should be so started unless on a circuit all its own. An induction motor is the best means of starting the larger machine.

The average man will do well to read carefully the discussion of lightning protection in Chapter VIII., which is beautifully summarized in the first paragraph of p. 149. About the most that can be said at present is that many lightning arresters work well a large part of the time.

The wiring data in Chapter XIV. will be found most convenient, but it should be borne in mind that the assumed power factors can be reached in practice only by the greatest care. In the average plant the power factor will be found to be something like 10 per cent. less. The author's references to resonance might have been amplified to great advantage, for this subject is one of growing importance, particularly as regards resonance of the harmonics which

is far commoner than is generally supposed and considerably increases the difficulties of insulation under certain conditions.

In spite of this necessary fault of over-condensation, Mr. Oudin's book will be found most useful for reference and should have a wide circulation. It is easy reading for anyone fairly grounded in electrotechnics, and contains a great amount of valuable and clearly put information. One foresees a long job ahead of the author in keeping it revised up to date, "even to many editions," for it should be deservedly popular, and the treatment is such as to require being kept sharply up with the time. It is by all odds the most practical monograph on the subject which has yet appeared.

LECONS SUR L'ELECTRICITE. By Prof. Eric Gerard. Tome Second. Applications de l'Electricité à la Téléphone, â la Production et à la Transmission de la Puissance Motrice, à la Traction, à l'Eclairage, à la Métallurgie et à la Chimie Industrielle. Paris: Gauthier-Villars et Fils, Editeurs. 790 pages, 387 illustrations.

In the 791 pages of this book and with the aid of the 355 illustrations included, an excellent view may be obtained of electrical engineering from the standpoint of Continental practice. The work is written as a book of instruction, and has, therefore, the advantage of systematic arrangement, and wherever possible the connecting links between theory and practice are given by the discussion of the principles concerned. The book is divided into sections, as follows: Distribution of electrical energy, including calculation and construction of lines, 12 chapters; Telegraphy, 3 chapters; Telephony, 6 chapters; Motors, direct and alternating current, 4 chapters; Electric traction, 5 chapters; Electric lighting, 5 chapters; Electrochemistry, 4 chapters. In the section on motors, the theory of the various types of alternating-current motors is very clearly developed and illustrated with respect to European commercial types. An interesting part of the book is a consideration of the various systems of simultaneous telephony and telegraphy. In the section on distribution, the questions of inductance of polyphase lines, phase-changing transformers, etc., are treated. The work should form an excellent book of reference for engineers and for teachers and students in electrical courses.

Directory of Electrical Societies, Etc.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, New York. Next meeting, Feb. 28.

AMERICAN STREET RAILWAY ASSOCIATION. Next meeting, Kansas City, Mo., October, 1900.

NATIONAL ELECTRIC LIGHT ASSOCIATION. Next meeting, Chicago, May 22, 23 and 24, 1900.

NORTHWESTERN ELECTRICAL ASSOCIATION. Next meeting, Waupaca, Wis., July, 1900.

NEW YORK ELECTRICAL SOCIETY. Next meeting, 8 p. m., Feb. 6, College of the City of New York, Twenty-third Street. Lecture by Prof. F. B. Crocker, "Observations on Electrical Matters in the Far East—China, Japan, Manila, India." Lantern slides. Ladies invited.

Arnold Magnetic Clutch.

IN the design of the modern electric power plant it is frequently found desirable to arrange the generators in such a way that they may be readily connected or disconnected to the prime movers according to the exigencies of the service. This requirement of station design has been met by Br. Bion J. Arnold in the system known by his name. As this system requires the use of clutches, Mr. Arnold has worked out a magnetic clutch, a number of which have already been built.

These clutches are in reality friction clutches, yet the friction between the contact surfaces is not due to mechanical pressure, but to magnetic traction. The working parts of the clutches are composed of metal having a high permeability so arranged as to become magnetized upon the passage of direct current through the coils with which they are provided. The two parts of the clutch can be attracted together in this way with a pressure far in excess of that obtained in mechanical clutches, and it is only a question of making

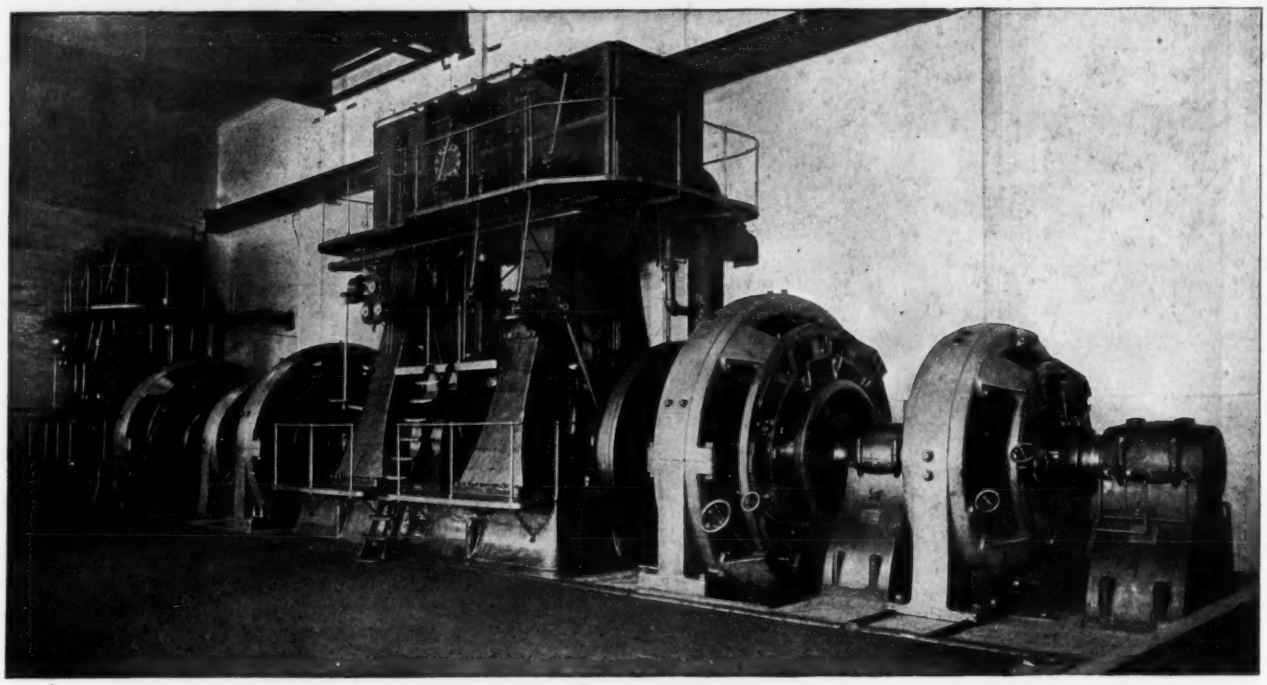


FIG. 1.—MAGNETIC CLUTCH CONNECTING ENGINES AND GENERATORS.

the clutches large enough to enable them to transmit power in any desired amount. The energizing circuit is controlled by means of a switch placed at a convenient point, which is quite a decided advantage over the ordinary friction clutch. It thus becomes possible in throwing a generator in or out of service to control it entirely from the switchboard, where all the regulating devices and measuring instruments are within the reach of one attendant.

These magnetic clutches also possess the advantages of neat appearance and compact design. Even in the larger sizes the amount of space occupied upon the shaft is not much more than twice the diameter of the shaft, and by using a flange forged solid on the end of the shaft, they can be made to occupy even less space when used as cut-off couplings. Owing to their having no projecting surface or parts to catch the air when in operation the windage resistance is negligible. The greatest advantage, however, of this form of clutch over others is the fact that it is self-contained—the "action and reaction" being within the clutch itself, and consequently there is no resulting end thrust upon the shaft bearings and no additional friction load due to the operation of the clutch.

The illustration, Fig. 2, shows the largest magnetic clutch in the world. It is 100 inches in diameter, and is capable of transmitting 3000-hp at 150 revolutions per minute. This clutch is one of three now in use connecting the engines and generators in the central station of the Imperial Electric Light, Heat & Power Company at St. Louis, a view of the equipment of which is shown in Fig. 1. The experience with this plant demonstrates that this form of clutch is ap-

plicable to the large size units now being installed for power station purposes, whereas the ordinary friction clutch becomes especially unwieldy and unsightly after passing the 500-hp size.

The current is carried to the clutch coils through contact rings upon the side of the clutch, and carbon brushes held by insulated brush holders. The electrical connections are simple and easily accessible for inspection. The clutch requires no more current than would be used by four 16-cp incandescent lamps, and the loss in the clutch due to the continuous use of the electric current while the clutch is in operation amounts to only one-hundredth of 1 per cent. of the power transmitting capacity.

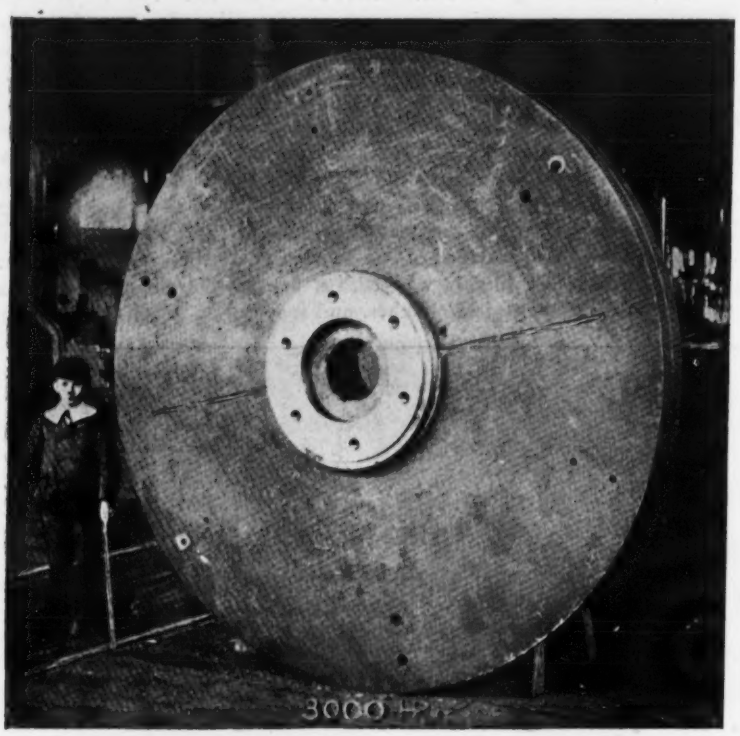


FIG. 2.—LARGEST MAGNETIC CLUTCH IN THE WORLD.

A number of these clutches have been made to connect large synchronous motors to their load in such a way that they can be quickly disconnected in case of accident, and they have also been built for use upon line shafting. They are also particularly applicable to use in connection with gas engines, as they would eliminate the flywheel problem of the gas engine in many cases, which of itself would be a distinct advantage. Indeed, there would seem to be no limit to their use wherever it is desired to transmit power from one shaft to another.

Primary Battery for Gas Ignition.

GAS IGNITING BATTERY.

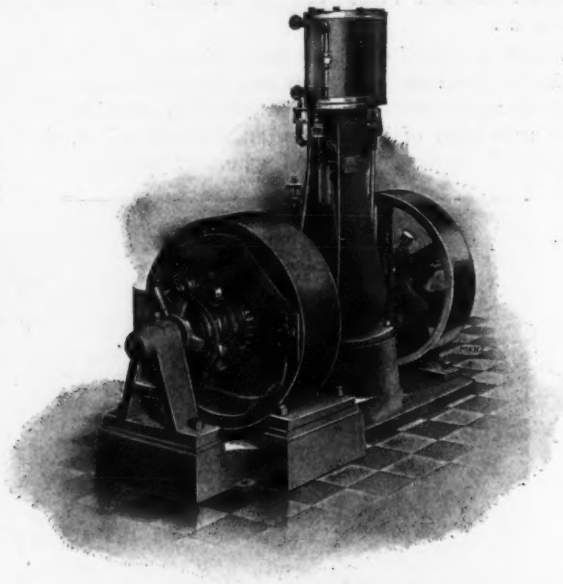
The accompanying illustration shows a primary battery that is used for gas ignition by many of the leading gasolene motor vehicle builders in this country, and manufactured by the Nungesser Electric Battery Company, of Cleveland, O.

In the production of this battery the company has carefully studied the requirements of prominent builders of gasolene carriages. One of the strongest claims is that it is long lived and requires no attention of any kind. A number of these batteries which have been in constant use, have shown, it is stated, a mileage of 5000 miles without attention or renewals. The battery is thoroughly sealed in screw-top hard rubber cells, and no leakage or slopping of solution can take place in the roughest kind of use. It is of the closed circuit type and it will not weaken, it is claimed, in the longest and heaviest service, giving a constant current discharge until completely exhausted. It does not require rest to recuperate, being ready to supply current whenever wanted. The Nungesser battery is used exclusively by the Winton Motor Carriage Company.

Small Direct Connected Unit.

The direct-connected unit illustrated herewith is typical of a line of small electric lighting plants manufactured by the Commercial Electric Company, of Indianapolis, Ind. They are especially desirable when the conditions require a high efficiency plant capable of being operated for long periods with little attention. The engine is provided with the improved Rites governor, giving the closest regulation possible and has an efficient system of sight-feed lubrication.

In the dynamo construction, the conditions conducive to high efficiency of operation have been carefully studied, and in the design finally adopted it is believed the highest point of economy obtainable by the use of the best material and exact proportions has been secured. In the selection of the material for the dynamo frame, the universally recognized magnetic superiority of soft steel over cast-iron has determined its use for every part of the magnetic structure.



SMALL DIRECT-CONNECTED UNIT.

The armature is of the ironclad type with machine wound coils, each of which is separately insulated and tested, insuring perfect insulation of the complete armature. The great strength of the steel field magnets and the use of a commutator with a large number of segments makes the regulation of the machine unusually perfect and results in entire freedom from sparking under all loads. These plants are built in sizes from thirty lights upwards.

The Davis Improved Police Electrical Signaling System.

The art of police signaling at the present time involves the transmission over a line of a variable current of long or short duration, which acts upon a receiver at a central office which works in synchronism with the transmitting device. The transmitting apparatus must be specially constructed, so that if it is desired to send a current of long duration over the line to the central office, there has to be a corresponding arrangement of mechanism in the transmitter to produce the desired results at the receiving station.

The new and improved Davis police signaling system, illustrated herewith in Figs. 1, 2 and 3, does not depend upon the transmitting instrument to give any but an ordinary signal, denoting the number of the signal and the box number, which are printed on the tape on the receiver. For instance, Box. No. 5 would be recorded by five dots and a pause; Box No. 23 would be two dots, a pause and three dots, etc. The printed tape first records the signal, then the box number. Signals may be designated as follows: One dot for duty report, two dots for wagon, three dots for ambulance, four dots for telephone, etc., and these may be increased to any number which are likely to be needed in a police signaling system. Any number of boxes can be used in the same circuit. It is evident that the use of this simple code of dots greatly simplifies the work of signaling.

The system also includes a register which perforates the paper tape instead of printing the dots by pen and ink, and also a type of register which prints numerical characters instead of dots.

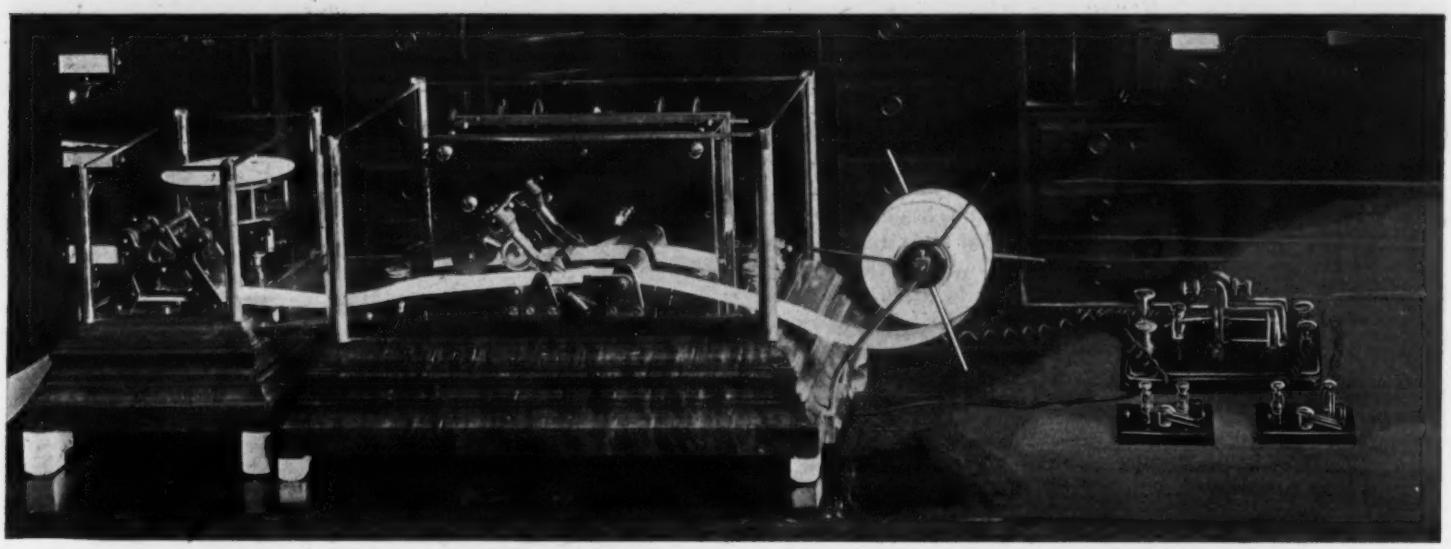
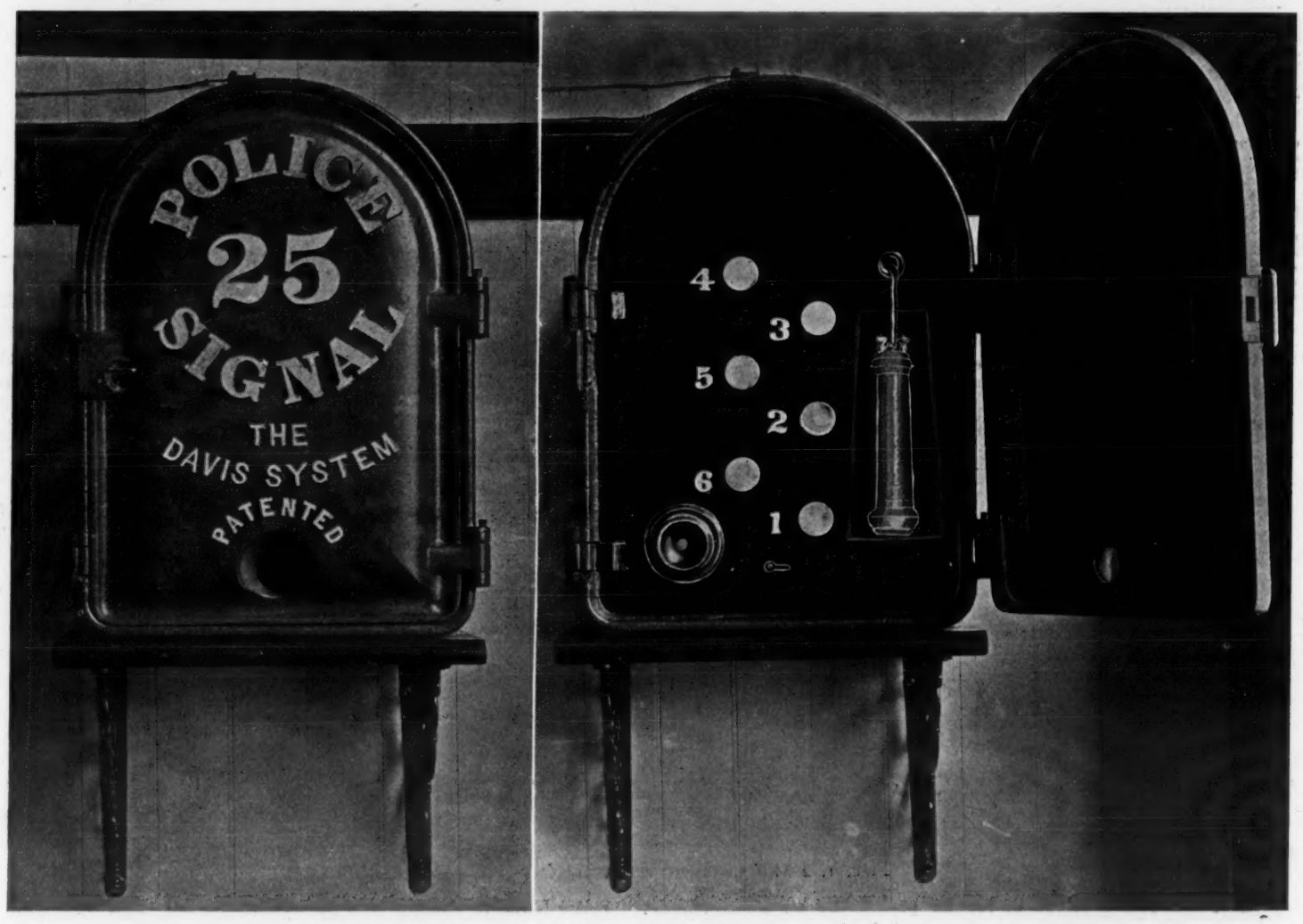


FIG. 1.—RECEIVING APPARATUS, DAVIS POLICE SIGNALLING SYSTEM.

The Davis signal system depends entirely upon the attendant in the receiving office for its operation. It is under his control to receive a signal from any person he may desire to communicate with. The character of the signals is controlled by means of an adjustable dial. For example, if the signal "three dots" is wanted to give a bell alarm on any particular circuit, it can be had by an instant adjustment of the receiving instrument, and this applies to any signal wanted. No particular code is used; and no variable resistances are used for an alarm or other signal, but simply plain dots and plain printing, which any one can read. By reason of the simplicity of the apparatus, the system is rendered more reliable and can be easily kept in order.

The advantages claimed for the Davis police signal apparatus are briefly as follows: It is more efficient; if desired, it will transmit a greater number of telegraphic signals, besides combining a telephone system; it is more reliable on account of its simplicity and construction; it is easily adjusted and kept in order; signals can be more quickly transmitted and received; and the signals, whether audible or inaudible, are under the control of the attendant at the receiving station, this latter being an entirely new feature that will be greatly appreciated by all police officials. To operate a box it is only necessary to press the button once.



FIGS. 2 AND 3.—SIGNAL BOXES OF DAVIS POLICE SIGNALLING SYSTEM, DOORS CLOSED AND OPEN.

It is stated that the system can be maintained at a much less cost

than has been attained heretofore. It is operated by a central main battery. This is applied in the manner known as the common battery system for the use of the telephone transmitter in the street signal box, thus doing away with the local telephone batteries.

The system as described above is covered by patents issued to Mr. Edward Davis both in this country and in Europe, and steps are now being taken for its early introduction into England. With regard to that, inquiries for further information should be addressed to Mr. R. W. Gordon, Hastings House, Norfolk Street, London. To handle this system in the United States a number of prominent gentlemen are now organizing a company, to be known as the "American Police & Fire Signal Company," with headquarters at 261 Broadway, New York. It is understood that several large contracts for the Davis signal apparatus are being closed, which will keep the factory of the company busy for a long time to come. The new concern enters the field with the intention to manufacture new and up-to-date fire-alarm and police signal apparatus for the use of cities, towns, institutions and hotels, thus covering the whole field of instantaneous warning and protection to life and property.

The Harris Recording Wattmeter.

We illustrate and describe on this page a new type of recording wattmeter for either direct or alternating circuits which has been developed by the Federal Instrument Company, of Albany, N. Y., under the patents of Mr. Jesse Harris. The chief distinguishing characteristic of this new meter is the fact that it is not a motor meter, i. e., a motor with a torque proportional to the load drawn through the meter is not used to drive a train of recording gears and a retarding brake. The current upon entering the meter passes through the fixed coils of an electrodynamometer, similar to the well-known Siemens dynamometer. This dynamometer has no iron in its structure, so that the instrument is useful on either direct or alternating circuits. This dynamometer appears in the left-hand side of the interior of the instrument, as shown in the cut.

The movable coil is a potential winding connected across the circuit so as to get the impressed voltage; thus the torque is proportional to the load passing through the meter. The movable coil is mechanically connected to an arm carrying a small roller which rides between two cylinders. The lower cylinder, called the recording cylinder, is revolved at regular periods by an electromagnet which appears in the right-hand part of the instrument, the armature of this electromagnet engaging a ratchet wheel and winds up a small spring. When this spring, through the medium of an accurately adjusted balance, runs down, a contact is closed through the electromagnet across the mains, winding it up again. Thus the recording mechanism is kept in constant action, and the motion of the recording cylinder is transmitted to the upper or integrating cylinder by means of the roller carried by the dynamometer, the amplitude of the motion transmitted depending upon the position of the roller in respect to the raised portion with which the recording cylinder is provided. This is wedge shaped, the point

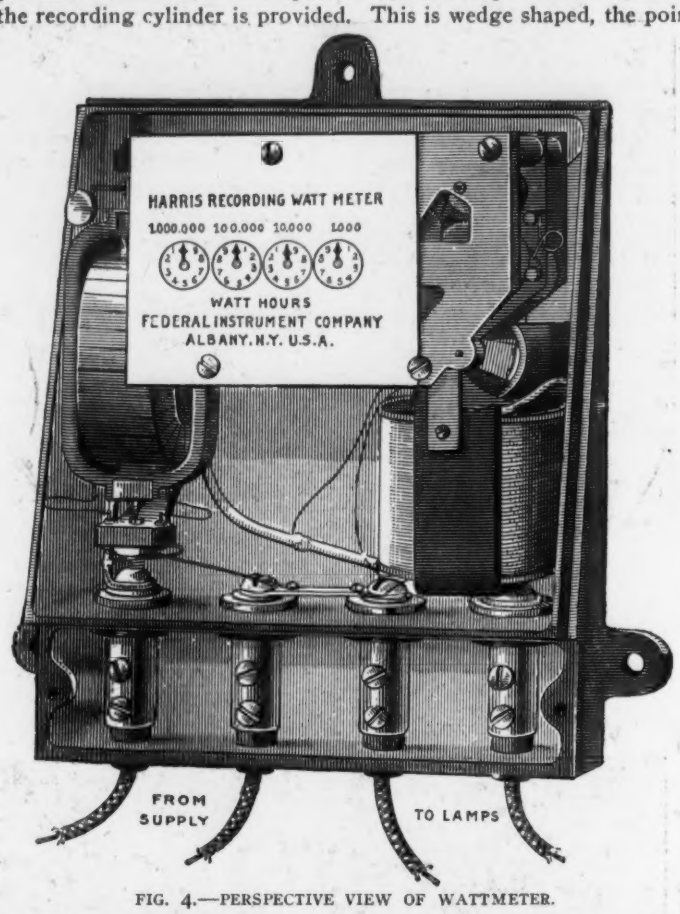
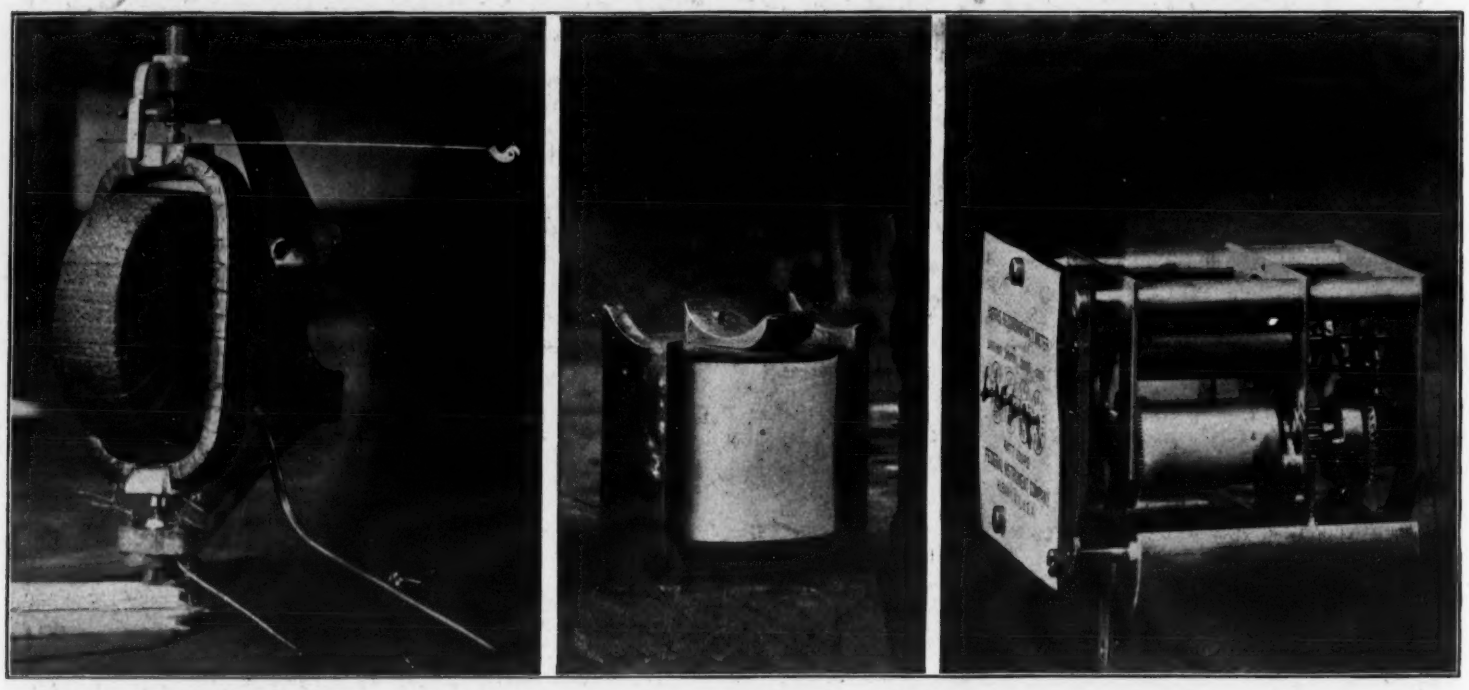


FIG. 4.—PERSPECTIVE VIEW OF WATTMETER.

corresponding with the zero or no load position of the dynamometer.

The upper cylinder is geared to the recording train. While the roller is out of contact with the cylinders, as it is for a portion of each rotation, it is frictionless and free to move under the influence of the dynamometer and can take any proper position determined by changes in load. As the recording train is driven by a power entirely independent of the measuring dynamometer, the latter is not impeded by friction. In fact, the instrument is as sensitive at no load as at full load, and the friction of the recording mechanism does not affect its indications at all until it should become so great



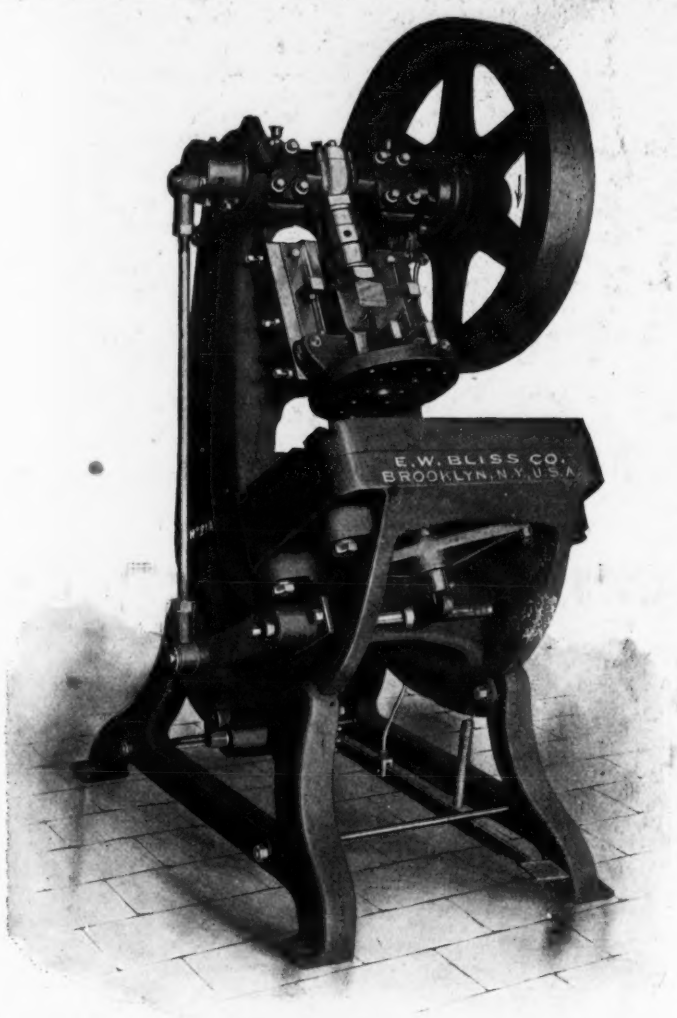
FIGS. 1, 2 AND 3.—MECHANISM OF RECORD WATTMETER.

as to absolutely impede the motion of the powerful driving apparatus.

The meter is solidly built and is constructed more on the lines of a machine than of an instrument, and should be capable of withstanding considerable rough treatment without affecting the accuracy. It is very small and compact, being only 7¾ by 6¼ by 3½ inches for from ten to one hundred lights. The construction is such that it may be used interchangeably on direct current and alternating currents of any number of alternations, and will record the energy consumed with equal accuracy. This feature makes it very advantageous to stations operating both direct and alternating currents or operating alternating current of different alternations.

Improved Armature Disc Cutting Press.

The press illustrated in the accompanying illustration shows a type of machine specially adapted for cutting simultaneously the inside and the outside of plain armature discs, with or without the key notches, and up to 12 inches in diameter. The discs as they



ARMATURE DISC CUTTING PRESS.

come from this machine are ready for notching by means of an automatic press. The press may also be used for cutting the outside, including the notches, simultaneously with the inside opening, when the aggregate cutting edge does not exceed 50 inches.

Heretofore an upright straight sided press has been the standard type of machine for the kind of work mentioned above. The press illustrated may also be used in an upright position, but its inclinable feature is, however, a great advantage, as it enables the operator to increase the output very materially, the punched discs falling through the back of the press by gravity, instead of having to be removed by hand as is the case with upright presses.

An interesting feature of the press is the crank-actuated knockout for the lower die, with the connecting rod back of the throat so as to leave the entire throat space clear for the sheets to be introduced sidewise. This knockout has a stroke of 1 inch, and the knockout in the slide has a movement of five-eighths of an inch. The diameter of the flange on the slide is 13½ inches; the opening in the bed is 14 inches diameter, so as to drop through plain blanks up to that size. The bolster, which is slotted, has an area of 17x20 inches front and back by right and left, and is 3 inches thick. Some of the other important dimensions are as follows: Distance back from center of slide, 9 inches; width of opening in back, 13½ inches; distance from bed to slide when stroke and adjustment are up, 10 inches; stroke of slide, 2 inches; adjustment of slide, 2½ inches; weight of fly wheel, 750 pounds; weight complete about 3750 pounds.

This press has been built very recently by the E. W. Bliss Company, 43 Adams Street, Brooklyn, N. Y.

A Self-Adjusting Drill Grinder.

When an invention is so new that the patent office cannot find anything pertinent in the prior art to which to cite the inventor, he may consider that he has discovered an entirely new principle. Such, we are informed, was the case in the machine that we illustrate herewith. While the enormous consumption of twist drills and their universal use has led inventors to study the problem of grinding them mechanically correct, it has always proved more difficult to accomplish than the superficial observer supposes, and still more so to embody these ideas in a machine adaptable to all sizes of drills. In the drill grinder illustrated herewith, however, it appears that all lines and angles involved in the problem have been brought into such geometrical relation with each other in the de-

SELF-ADJUSTING DRILL GRINDER.

sign of the machine itself, that further improvement would seem impossible.

The holder of this new machine, unlike others, swings upon a journal positioned back of the grinding face of the wheel, the axial line of which journal, if extended upwardly, would pass through the body of the wheel and intersect the apex of the "V" holder substantially at the grinding surface of the wheel. Consequently a small drill resting in the bottom of the holder would have its point near this imaginary line, and the cone upon which the cutting end of the drill is ground would be very small, as the circle that it swings on at that point would also be circumscribed.

The angles of the "V" sides of the holder are formed in such relation to this axial line of oscillation that as drills increase in size they must rest further above the apex of the holder; when in position to grind, their points will be thrown further ahead of this imaginary line just in proportion to their increase in size. There-

fore the lines upon which the machine itself is constructed become its own adjusting device, and automatically accomplishes in this machine the results obtainable in others only by the manipulation of caliper devices, gauge jaws, chucks, etc. It will thus be seen that there is no guesswork about the solution of this problem. The lines upon which it is solved are both mechanically and scientifically correct. It may also be readily observed that by the proper arrangement of these angles and lines in relation to each other, drills of different sizes automatically find their places in just the proper position to be ground mechanically correct. A small drill cannot possibly occupy the place of a large one, and vice versa.

The preliminary adjustments required to set the machine to grind a drill to any size within its range are therefore reduced to barely one, and this one only consumes a second or two of time. The operation is as follows: Drop the drill into the "V" holder and bring up the tail-stock to suit the length of the drill. The process is thus necessarily shortened to a minimum, for it would be impossible to further reduce it, as the number of adjustments can never reach less than one.

It will also be seen that this arrangement does away with the necessity of safety stops, or of any danger of marring the lip-rest while the machine is in use, as the holder is never moved except to follow up the wear of the wheel. Another new and important feature is the variable clearance device. By loosening the hand wheel beneath the bottom of the holder it may be instantly adjusted upon its curved bearing by means of a clearance screw not visible in the cut. This adjustment gives any angle of clearance to the cutting edge desired and, as may be readily understood, the same angle of clearance holds good upon every size of drill within the range of the machine (⅛ to 2¼ inches) without resetting. This is a feature peculiar to this machine, and due to the fact that the curved seat in which the holder rests is struck from the apex of the holder itself. It would appear that the limit of efficiency and improvement has now been reached in this important process. This machine is made by the Fuller Manufacturing Company, successors to G. T. Eames Company, of Kalamazoo, Mich.

New Switchboard in Franklin Building, New York.

The cuts herewith, Figs. 1 and 2, show the switchboard recently installed in the Franklin Building, No. 9-15 Murray Street, a building which was designed and erected with facilities for such heavy manufacturing as requires the use of electrically driven machinery. The switchboard is considered one of the latest and best examples of modern switchboard engineering, and is arranged to allow rapid manipulation of the various switches located on same.

Three dynamos are installed, for each of which there is a separate panel, on which are mounted an Ideal circuit breaker of 400 ampere capacity, a Thomson recording wattmeter, regulating rheostat, and a triple pole double-throw quick break La Roche knife blade switch. In addition to this, the board contains two voltmeters, each provided with a voltmeter switch. Two additional ammeters are also mounted thereon, one of which indicates the total current on the switchboard, and the other the current used on each floor. This latter ammeter is used in connection with a 16-circuit.

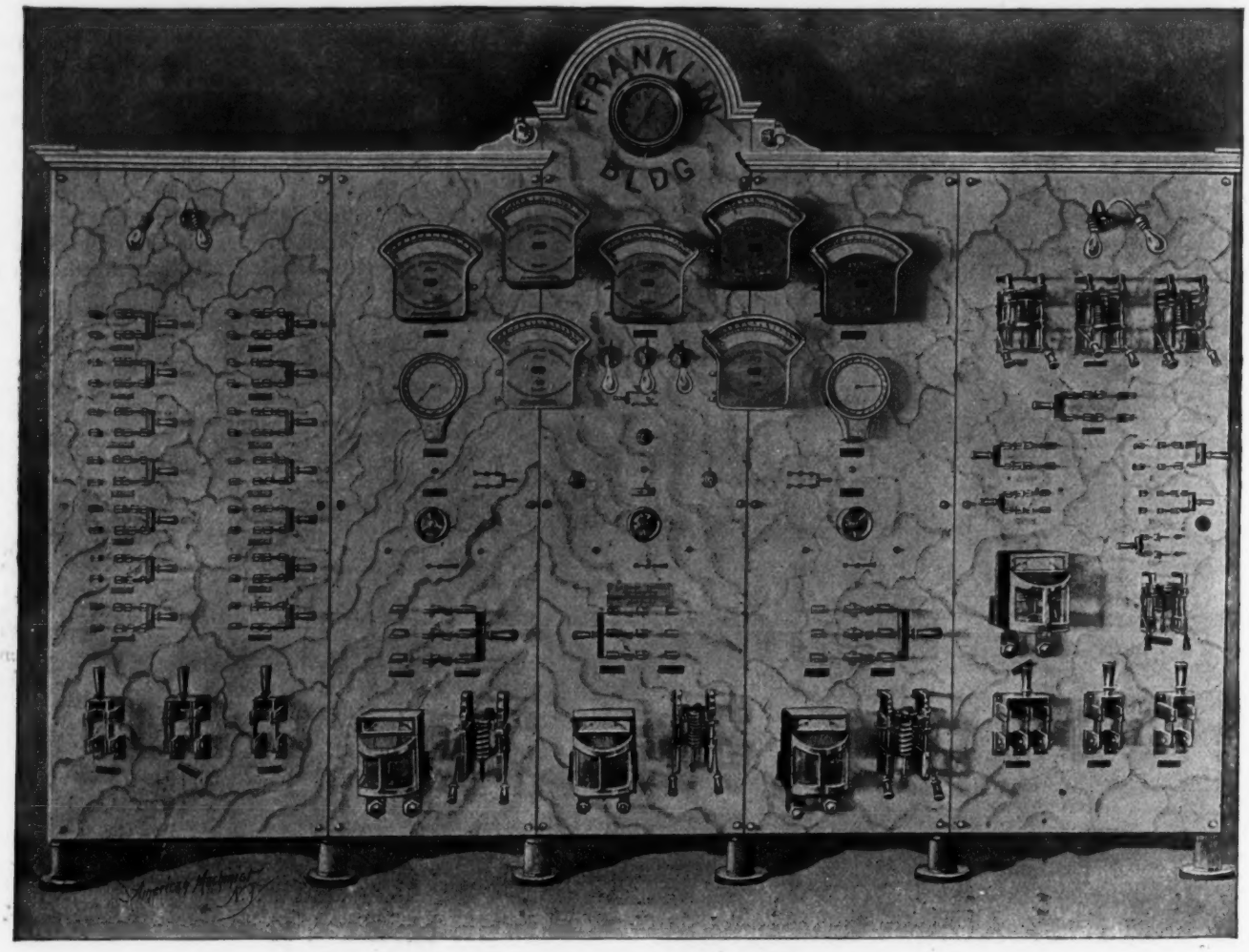


FIG. 1.—SWITCHBOARD, FRANKLIN BUILDING, NEW YORK.

At the top of the board a standard marine clock, of the Empire Electrical Instrument Company's make, is mounted, and two Bristol recording instruments are also in place. The switchboard is arranged to connect the three generators with two systems of distributing circuits, one being used for lighting and the other for power. A street service connection is also provided, by means of which any part of the system may be operated from the street mains. At the same time the remainder of the system may be operated from the generators. Any one of the generators can be connected with the entire distributing system, or the lighting and power parts may be run separately. Each of the lighting and power circuits is controlled by a double pole double throw quick break switch, and each power circuit is further protected by a double pole circuit breaker.

All connections are located on the rear of the board and are made of heavy bars of hard drawn copper. These connections are shown diagrammatically in the cut. As will be seen, the three gen-

erators are connected with the system in the same order, and the current from each generator passes through the Ideal circuit breaker, then through the recording wattmeter to the triple pole

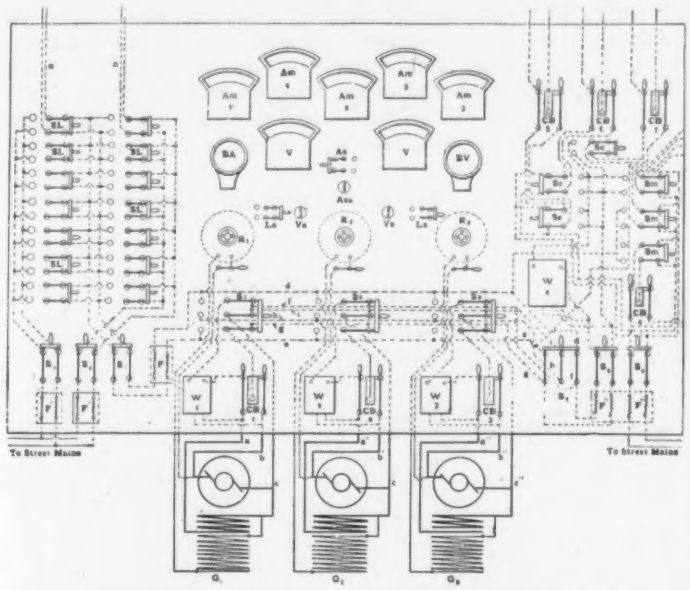
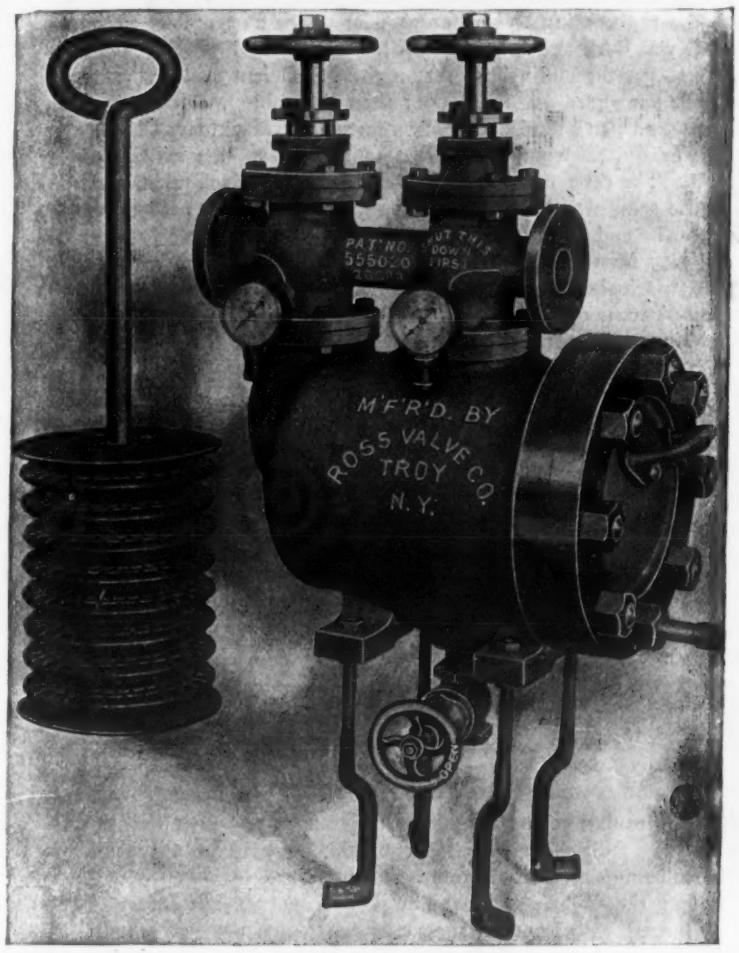


FIG. 2.—DIAGRAM OF SWITCHBOARD CONNECTIONS.

switch, whence it flows into the busbars, which extend to the right and left across the board.

The left hand side shows the lighting section with the various switches for lighting circuits, one side of these double throw switches being arranged for connection to the street main. The right side of the board shows the power section. The upper row of Ideal circuit breakers with the three switches beneath them, control the three elevator circuits. The current feeding these three switches passes through the recording wattmeter, which registers



ROSS FEED WATER FILTER.

the amount used for the elevators. The other small circuit breaker and switch control and protect another power circuit. All the above switches are of the La Roche quick break type, and are made double throw to provide for feeding these circuits with street current, if it should become desirable.

This handsome switchboard was built and installed by Messrs. F. A. La Roche & Co., Thirteenth and Hudson Streets, New York City, who have recently installed switchboards for isolated plants, embodying their Ideal and La Roche appliances, in many of the large office buildings in New York City.

Ross Feed Water Filter.

In surface condensing steam engine plants the removal of oil from the water of condensation which is to be used again as feed water is a very important consideration. The apparatus shown in the accompanying illustration, which is made by the Ross Valve Company, Troy, N. Y., is designed to accomplish this object in the most thorough manner. It consists essentially of a chamber containing a bag made of the fabric known as Turkish toweling, folded in such a manner as to present a large area of filtering surface in a small space. The bag is drawn over the bronze skeleton shown at the left of the cut, and drawn down over the corrugations by means of strings. This permits of increasing the filtering surface from 250 to 1000 times the area of the feed pipe, according to the service required. The toweling allows the water to pass through it readily, but the threads catch the oil and retain it.

When the material becomes saturated with oil, the filter may be cleansed by reversing the direction of the current, allowing the wash water to run to waste, or by substituting a reserve filter bag. The bag may be readily changed by opening the head of the filter chamber, and this operation need not consume more than five minutes of time. The clogging of the filter material is indicated by the difference in the readings of the two pressure gauges, one on the inlet and the other on the outlet side of the filter. The water of condensation passes from the outer side of the filter bag, through it and the metal skeleton to the interior of the latter and thence to the outflow pipe.

Long Telephone Cable Across Mackinaw Straits.

Note was made a month or two ago in these pages of the laying of a long telephone cable across the Straits of Mackinaw, and the matter has attracted so much attention that inquiries have even been addressed to us from abroad on the subject. We are glad therefore to be able to furnish a few further details, and some photographs, in regard to the operation, which is one of the most important of the kind ever attempted in the United States.

The longest submarine telephone cable of its size ever made and successfully laid now stretches across the Straits of Mackinaw, from Mackinaw City to St. Ignace. It is operated by the Michigan Telephone Company, a part of the Erie Telephone & Telegraph Company's system, and permits direct communication between the Upper and the Lower Peninsulas of Michigan, connecting the immense copper country of Northern Michigan by telephone with the rest of the United States. During the coming spring a second section of similar cable will be laid between St. Ignace and Mackinac Island. The contract for furnishing the cable complete ready for use was placed with the Western Electric Company, of

FIG. I.—SIX MILES OF CABLE ON REELS.

Chicago, which in turn placed the order for the manufacture of the cable with the Simplex Electrical Company, Boston, through the latter's Chicago agent, Mr. H. R. Hixson. The total length of the two

sections will be nine miles, something over half of that quantity having been used between Mackinaw City and St. Ignace.

The cable is of ten pairs, two pairs of No. 14 B. & S. and eight pairs of No. 16 B. & S. gauge. Each conductor contains seven strands and is insulated to 8-32 inch diameter with rubber compound of special high quality for submarine work. Over the cabled conductors are two heavy friction tapes put on in reverse directions. then follow two serves of tarred jute also in reverse, and finally the cable is armored with No. 6 B. W. G. galvanized steel wire. The specifications called for an insulation resistance of 500 megohms per mile, and a maximum copper resistance of 14 ohms per mile for the No. 14 wires and 24 ohms per mile for the No. 16 wires. The finished cable measures about 2¼ inches in diameter, and weighs fifteen tons to the mile.

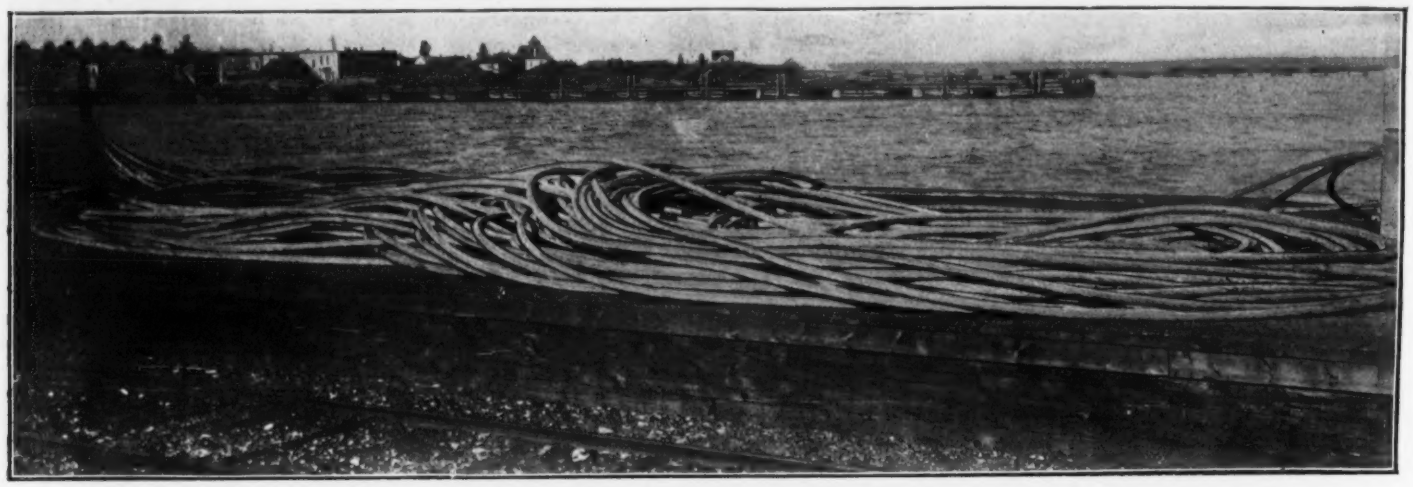


FIG. 2.—COIL OF ONE MILE OF CABLE.

The Simplex Company shipped six miles of cable on reels holding one mile each, to Mackinaw City, Mich. (Fig. 1 shows four of these reels.) At this point the Western Electric Company took entire charge of all work except the splicing together of the several lengths. The cable was first removed from the reels and coiled on the dock. Fig. 2 shows one mile thus coiled up. The splicing was done by the Simplex Electrical Company, in a shanty built for the purpose, and all rubber patches were vulcanized on an electric heater designed especially for this work by the company. As there was no electric light of power plant in Mackinaw City, the Western Electric Company set up one of their 2½-hp dynamos in an adjacent sawmill, to furnish current for this heater and for a few lights—a pole line carrying wires to the shanty on the dock. Ten days were needed to complete the five splices and make necessary tests. The splice in the armor was made by lapping the armor wires from one side over the wires on the other side about eighteen feet, and then serving with smaller wires at intervals to hold the whole in place. Fig. 3 shows a completed splice fastened up on the side of the shanty. Mr. George R. Slater, of the Western Electric Company, had general superintendence of the handling and laying the cable, the actual work being in charge of Mr. A. Swanson, of the same company. The splicing and testing was under the supervision of Mr. H. A. Morss, of the Simplex Electrical Company.

As there are no vessels on the Great Lakes suitable for laying cables according to the approved methods employed on ocean cable ships, a large flat scow and two tugs were employed, the hold of the scow being divided lengthwise by a bulkhead, leaving a long narrow space on each side about 150 x 10 feet, and about two and one-half miles of cable were coiled on one side and three and one-half miles on the other. The coil was of the common figure eight form with the cross very near one end, and great care was taken to prevent the possibility of a snarl in paying the cable out, each layer being separated from the one below by strips of wood and each turn in a layer being placed inside the previous turn. From the hold the cable led up through a forward hatch and aft along the deck through inverted U-shaped iron guides. At intervals were three brakes controlled by sixteen-foot levers, by means of which it was possible to stop the cable from paying out, even with the tugs steaming ahead.

A little over one day was occupied in coiling the cable on board, and it was then necessary to wait two days for suitable weather; but on the second day an early start was made, and within half an hour the lighter and tugs were off the cable landing on the Mackinaw City side of the Straits. The water was so shallow that the tugs could not approach nearer shore than about 1000 feet, so a line was sent ashore and the cable made fast to it. The cable end was then placed in a small boat to keep it from catching on rocks on the bottom, and about twenty men began pulling it toward shore, but soon the amount of cable out became to heavy that they could not move it. Then a tackle was used and the cable advanced a little at a time, but owing to the distance and the weight of the cable (nearly six pounds to the foot) this was a slow process, and it was half-past 1 o'clock before the end was ashore and all hands were on board ready for the run across the Strait.

The tugs started and the cable was paid out at the rate of about two miles an hour until near the St. Ignace shore, when a reef of rock not shown on the government chart, and directly in the course of the cable, was encountered. Over this there were only about five feet of water, which was less than the draft of the tug. Soundings showed that the reef was short, and the cable was carried around its end, the tug coming to anchor as near shore as possible. By this time it was dark and a heavy rain had set in, so it was decided not to try to get the end ashore that night. Sufficient cable to reach to the pole on shore was paid out; then the cable was cut, the end thrown overboard, and everybody returned to Mackinaw City.

The next day a small scow was secured and a start made about 2 o'clock. The cable end was picked up and all the slack taken aboard; then the scow was hauled close to shore, cable being paid out as it went. The end was finally taken ashore to the cable pole just before 5 o'clock. Men being already at the Mackinaw City end with a telephone, a telephone was also connected on the St. Ignace end, and communication opened. Each of the ten pairs was talked over in succession and operated perfectly. On Friday, the following day,

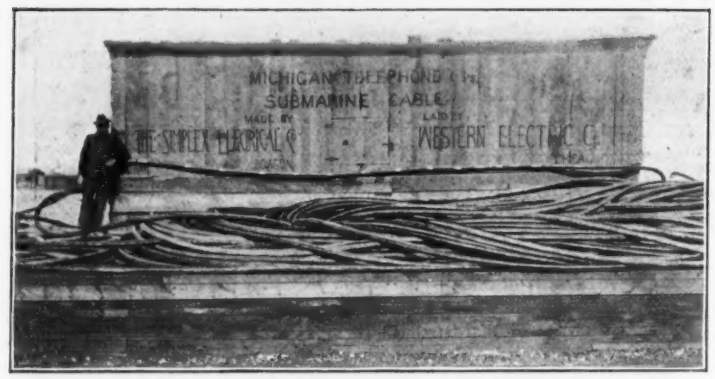


FIG. 3.—COMPLETED SPLICE.

tests for insulation and conductor resistance showed the cable well above the requirements in all particulars, the average insulation resistance being over 1000 megohms per mile.

Among the officials at Mackinaw City to witness the laying of the cable were E. W. Bennett, superintendent department of supplies of the Erie Telephone system; Messrs. Holmes and Slater, of the Western Electric Company; Messrs. Sherman, Hall, Thompson, Beeston and Crouter, of the Michigan Telephone Company, and Messrs. Hixson and Morss, of the Simplex Electrical Company. Messrs. P. G. Reynolds, J. Harper and A. Grauer also visited Mackinaw City during the preliminary work.

NEWS OF THE WEEK.

Financial Intelligence.

THE WEEK IN WALL STREET has been marked by general dulness and an attitude of waiting due to the uncertainty of results in the Transvaal and the consequent effect on English and international finance. There has been more ease in the money market, and a fair demand for bonds, but the stock market has been slow in movement, with little actual business doing. Most activity has been shown in New York traction securities, which have seesawed under the influence of varying conditions and reports. Western Union sold down to 86½ on dealings in 1616 shares, and General Electric was firm at 123 on sales of but 630 shares. Metropolitan Street Railway was up to 167⅜, a gain of 2⅞ on 35,740 shares, and Manhattan Elevated went up ¼ to 93⅜ on 25,000. For the week, Brooklyn Rapid Transit made a gain of ⅝ up to 71¼ on 176,710 shares, and with the election of directors assumed to represent Vanderbilt and Standard Oil interests. Third Avenue continued weak around 110 on the news of its attempts to raise $17,000,000 to cover debt. Twin City Rapid Transit pref. closed at 138 and common at 68½, both showing advances. In Boston, the closing prices were: American Bell Telephone, 335; Erie, 105; New England, 135; Michigan, 100-105; Boston Elevated, 96½; West End, 92½; Mass. Elec. Railways, 21¾ common, 76¾ pref. In Philadelphia, closing prices were: Am. Railways, 4⅞-5; Consol. Traction, N. J., 62; Consol. Traction, Pittsburg, 28⅞; Elec. Storage Battery, 78-79 common, pref., 80-80½; Penn. Elec. Veh., 8-8⅛ common, 3½-3⅝ pref.; Gen. Elec. Automobile, 5⅞-6; Phila. Electric, 5¼-5⅜; Phila. Traction, 97; Union Traction, 38-38⅛; Elec. Co. of Am., 12¼. In Chicago, the chief closing prices were: National Carbon, pref., 82¾; South Side L., 100; Lake Street L. certs., 10; West Chicago Railway, 111; Metropolitan L. 4's, 95⅝. In the New York outside market, Elec. Axle Light & Power closed at 4-4¼. Data as to its new consolidation is given in another paragraph. Electric Boat, 16-18 common, 35 pref.; Electric Vehicle, 40-45 common, 50-60 pref.; Illinois Elec. Veh., 2¼-2¾; N. Y. Elec. Veh., 9-9½; New England, 6¼-6½; Otis Elevator, 22-25 common, 86-89 pref., Union Traction, pref., 75¼.

ELECTRIC AXLE MERGER.—Plans for the merger of the Electric Axle Light & Power Co. with the Consolidated Railway Electric Lighting & Equipment Co., have been completed, and a circular has been issued by the latter company to the stockholders of the Electric Axle Co., setting forth the terms of the proposed merger. Electric Axle stock is to receive for every 100 shares, second assessment paid, sixty-seven full paid non-assessable shares of the Consolidated Company. The acceptance of the plan of merger is assured, as 70 per cent. of the stock of the Electric Axle Co. expressed approval of the terms before the issue of the circular. The Consolidated Railway Electric Lighting & Equipment Co. was recently formed under the laws of the state of New Jersey with a capitalization of $16,000,000 and was incorporated for the purpose of combining a number of railway lighting and brake companies, the largest and last company to be absorbed under the present plan being the Electric Axle Co. The other companies in the Consolidated are the Columbian Electric Car Lighting & Brake Co., American Railway Electric United Lighting Co., European Railway Electric Lighting Co., United Electric Lighting Co., Lindstrom Brake Co., and the Railway Triplex Ticket Co. The Consolidated Co. is said to own a number of valuable railway equipment patents and it has already made contracts with a number of large railroads, including New York Central, Pennsylvania, Baltimore & Ohio, Illinois Central, Union Pacific, and Canadian Pacific. Under the plan of merger the Electric Axle Co.'s stock upon payment of the second assessment, and on being deposited in the State Trust Co. on or before Feb. 3, will be exchanged for Consolidated stock in the proportion named. It was not announced how much of the Consolidated Co.'s stock has been used for the purchase of the companies already absorbed, but it is said that the purchase of the American Axle Co.'s stock will require practically all the stock at present in the treasury of the Consolidated Co. Isaac L. Rice, who is chairman of the board of directors of the Electric Axle Co., is president of the Consolidated Railway Electric Lighting & Equipment Co. and is actively working out the details of this very comprehensive scheme.

BROOKLYN RAPID TRANSIT.—The following are the new directors of B. R. T. elected last week at the annual meeting: August Belmont, H. H. Porter, E. H. Harriman, W. G. Oakman, A. R. Flower, F. P. Olcott. Of last year's directors the following have been re-elected: C. L. Rossiter, A. N. Brady, T. S. Williams, Henry Seibert, J. G. Jenkins, D. H. Valentine, H. C. Du Val. The total vote cast was 434,504 out of 450,000. A director of the company said last week: The strength of the board of directors is clearly evident. From the financial standpoint there should be little trouble ahead. Our road is in the best shape it has ever been. We expect to shortly receive 300 new cars which have been contracted for. Our whole line is rapidly being equipped with electricity and we fully expect that by April every mile of the road will be operated by one power. We opened the Lexington avenue line last Wednesday, thereby adding 12 miles to the electrical system. The congestion of traffic at Brooklyn Bridge has been considerably relieved and the patronage over the bridge increased over 100 per cent. since we began using it. The objection to our transfer system in the suburbs is rapidly diminishing. In fact, the new arrangement is bound to increase traffic from the outlying districts.

INDEPENDENT TELEPHONY.—Projected conferences of manufacturers of telephones have been temporarily delayed, so it is said, by the unsatisfactory condition of the money market. Plans for the consolidation of the manufacturers of apparatus have not been abandoned, however, and interested parties allege that when present plans are completed close relations will have been found to exist between the principal operating company known as the Telephone, Telegraph & Cable Co., and its source of supply. That was the scheme that fell through recently. The Knickerbocker Telephone Co., of New York, is hardly expected to be in successful operation short of a year. While it would take much less time than that to complete local arrangements and solicit subscribers it has been decided to complete negotiations for long-distance connections before going to the public to solicit subscriptions to the service. It is, however, equipping temporary service and has canvassers out. There is some talk that the American District Telegraph Co., which has a valuable subways franchise, will figure in the new deal. The Western Union Telegraph Co. owns between 4000 and 5000 shares of this stock.

ELECTRIC CO. OF AMERICA.—Says a high official of the Electric Co. of America: "Of the 13 plants which we operate there is none that is not showing material increase in net profits, as compared with their respective earnings before they came under our management. This is due principally to economy of operation, though gross earnings have usually developed as well. Had we fifty plants to-day, the larger business, productive of proportionally increased receipts, could be handled with practically no increase in the cost of the executive management." The company has been in operation less than a year, has paid two dividends of 50 cents each, and after carrying over earnings considerably beyond the second dividend, for the last six months, it retains a cash surplus of some $300,000. The properties are averaging net profits of 12 per cent. on their cost and the stock at 12½ nets 8 per cent.

TELEPHONE IN PITTSBURG.—A special meeting of the stockholders of the Central District & Printing Telephone Co. is called for Feb. 15 to consider a proposition to increase the capital stock from $4,000,000 to $7,500,000 for the purpose of raising funds for new construction work. This stock is listed on the Boston Stock Exchange although very seldom quoted. It pays dividends of 8 per cent. per annum and sells from between 150 and 160, having advanced $20 to $30 per share within the past year. The new stock will probably be issued in instalments and be offered to stockholders at par. The company operates in the Pittsburg (Pa.) district, said to be the third best telephone territory in the United States. New York City and vicinity is claimed to be the best telephone district, Boston second, and the Pittsburg district the third.

DIVIDENDS.—The Chicago Edison Co. transfer books closed Jan. 25 for the purpose of issuing new stock and also for the payment of the regular quarterly dividend of 2 per cent., payable Feb. 1. The American Mutoscope & Biograph Co. has declared a dividend of 1 per cent., payable Feb. 1. Hawley Down Draft Furnace Co. has declared a dividend of 1½ per cent. The business of the company in 1899 was 100 per cent. better than the preceding year, and there is every prospect of further gains in 1900. The Northern Ohio Traction Co. has declared its first semi-annual dividend of 2½ per cent. on its preferred stock, payable Feb. 1.

CHICAGO UNION TRACTION.—The Chicago *Times-Herald*, of Jan. 26, says: "On the authority of men connected with the Chicago Union Traction Company, it is stated that large blocks of the stock of that corporation have recently been purchased by the

Rockefeller interests. As confirmation of the announcement, shares of the Union Traction Company in thousand-share lots have recently been transferred to New York names. These shares were purchased in the local stock market, were paid for in cash, and shipped East to their new owners."

BUFFALO, N. Y., TELEPHONES.—The Bell Telephone Co., of Buffalo, has completed negotiations for an increase in its capital stock from $2,000,000 to $5,000,000. The papers have been drawn and it only remains for the stockholders to approve the increase. The reason given for the increase is that it will provide additional capital to carry on the business and purchase some minor independent companies which are operating on the Niagara frontier.

ILLINOIS ELECTRIC VEHICLE.—The payment of the second instalment of 5 per cent. or $5 per share, due Feb. 1, 1900, has been further extended to July 2, 1900, with interest, as the company has adequate funds to meet the present requirements of its business. Subscribers or holders of certificates desiring to pay the secon instalment of 5 per cent. or $5 per share on Feb. 1 may do so, and the company will deliver stock certificates 10 per cent. paid.

NEW YORK UNDERGROUND.—Mr. John B. McDonald, who secured the contract for the Rapid Transit tunnel, is organizing a construction company which will put up the $6,000,000, in which amount he is required to qualify in order to complete the contract. There appear to be a good many hitches still, even in the preliminaries. August Belmont is named as backer.

NATIONAL CARBON.—It is said that during the year ending Jan. 31 the National Carbon Co. will earn 7 per cent. on the common stock, but no dividends on this stock are anticipated at present.

NEW ENGLAND TELEPHONE.—The New England Telephone & Telegraph Co. has declared a regular quarterly dividend of $1.50, payable Feb. 15.

Commercial Intelligence.

THE WEEK IN TRADE has been without any marked features of importance. There is a general maintenance of the activity and steadiness of demand that marked last year, while foreign critics in spite of the great figures of 1899 express the opinion that we are still behind Europe in the full expression of trade revival and expansion. In fact they assert that it will be two years before consumption here can in any degree overtake the conditions of supply, while by that time a further development may impend from the opening up of the Far East. As to immediate facts in the metal field, iron and steel prices, Dun's says, have been yielding for several weeks, and are a shade lower for products than at any other time since the middle of September, though Bessemer pig and billets are still so scarce and firmly held that only two sales amounting to 8000 tons are anywhere reported. Agreements to hold the price of bars do not prevent sales at Philadelphia for 2.07½ of iron considered by buyers best refined, though sellers call it common, and plates and sheets are both irregular there, with narrow plates sold at Pittsburg below 2.25. Structural shapes are not quoted lower, but the New York Central contract for 13,000 tons bridge material went to the Pennsylvania, Pencoyd and Detroit works, and two orders for 25,000 tons rails are taken at Chicago. Last year 13,620,703 tons of pig were produced, according to the official record, the consumption being 13,774,727 tons. There is a great deal of conjecture over prices for the steel for the New York underground electric railway tunnel. As to copper, Lake ingot is quoted at 16½ cents; lead 4.70, tin 26½. The quieter tone of business and speculation is reflected in the smallest volume of bank clearings, reported by Bradstreet's, for six weeks past, aggregating $1,609,432,056, a decrease of 6 per cent. from last week, of 25 per cent. from the week a year ago, but a gain of 67 per cent. over 1897, of 109 per cent. over 1894 and of 33 per cent. over 1892. Outside of New York there is a decrease shown of nearly 8 per cent. in clearings and of nearly 5 per cent. from the week a year ago. Business failures for the week number 252, as compared with 255 in the previous week, 246 in the week a year ago, 288 in 1898, 326 in 1897, and 393 in 1896. Net railway earnings for November indicate a continuance of favorable features affecting the transportation interest in a gain of 11.7 per cent. in gross and of 12.3 per cent. in net over November, 1898. Owing to the smaller grain movement and increased expenses of operation, the granger roads show a decrease in net returns from a year ago, while the central-western, the coal roads and the trunk lines show gains in the neighborhood of 21 per cent. For eleven months the gain in gross is 10.9 per cent., while net receipts are 12.4 per cent. heavier. Advance reports of earnings for the month of January are likewise encouraging, the gains noted over corresponding weeks a year ago ranging from 8 to 14 per cent.

STORAGE BATTERY MANUFACTURE.—The following data as to the operations of the Electric Storage Battery Co. is given as a statement by Vice-President Lloyd to the directors: "The sales for the year ending December 31, 1899, will amount to approximately $3,500,000, an increase of nearly 300 per cent. over 1898, when the business was $1,300,000. This increase has come from the wider use of batteries, and it is a constantly increasing ratio. The net profits on the business in 1898 were slightly over 22 per cent.; in 1899, with a larger business, they will be about 25 per cent. In other words, the current business is earning about $250,000 per quarter, or exceeding a rate of 6 per cent. upon the outstanding capital stock. This is independent of any dividends from vehicle stocks, which at rates paid last year would give us from stocks in our treasury an additional sum of $80,000 quarterly, or an additional 2 per cent. annually upon our stock. Since the enforcement recently of the injunction against infringements of our patents, opposition has practically ceased. The company has at present in bank, $125,000; goods manufactured, but undelivered, $500,000; bills outstanding unpaid, but good, $750,000; total working capital, $1,375,000. The company owes nothing except small current bills not exceeding altogether $60,000, and has no bonded or other indebtedness. The amount of plates manufactured by the company was 10,547,771 pounds in 1899, 5,125,625 pounds in 1898 and 3,607,318 pounds in 1897. The amount of orders taken was $3,500,000 in 1899, $1,340,489 in 1898 and $1,026,925 in 1897."

THE CROCKER-WHEELER COMPANY has just passed through one of the most successful years of its entire career, and finds itself now in a very strong and active condition. It has, during the past year, made quite a number of changes in its shop methods, and in the general designs of its machines, adopting certain standards which are carried out through all the different lines and sizes of apparatus manufactured by the company, thus bringing the machines down to the most practical basis, when considered from an economic and useful point of view. The machines as made by this progressive company, are thoroughly workmanlike and reliable in every respect, and can always be counted upon to do the work which is laid out for them, including some of the heaviest to which motors have been applied here or abroad. The Crocker-Wheeler Company has found it necessary to extend its selling lines quite materially in order to handle the business which is now before it. With this object in view, it has made certain changes in regard to agencies, the most recent change being the establishing of a Southern office in the English-American Building at Atlanta, Ga., for which it has engaged the services of Mr. Louis P. Hall, an engineer of considerable experience and ability, to represent the company in that territory. The company is in a most encouraging situation as to its foreign trade, and has a large quantity of apparatus installed in different parts of the world.

RAILROAD CAR REFRIGERATION.—The party of electrical and newspaper men who made the trip from New York to New Orleans to witness the test of the Electric Axle Light & Power Company's system of refrigerating cars by means of power applied from the axle have returned to this city. They reported that the experiments were successful and that they aroused a good deal of interest among railroad and business men. The fact that 30 degrees F. was reached with ease and maintained during a run of 321 miles from New Orleans to Montgomery led those on the trip to believe that the principle of refrigeration by electricity furnished from an axle had been demonstrated beyond question. Compared with the cost of cooling a car by means of ice the experts thought the electrical system would require but a fractional part of the expense. The trip was in charge of John T. Dickinson, general agent of the Electric Axle Light & Power Company.

APPARATUS FOR SPAIN.—We have received copies in French and Spanish of the conditions upon which alternating current apparatus is to be furnished for Zamora, Spain. Bids are requested. Water power is to be used, and the generators are to be driven by two Hercules-Progres turbines each of 500-hp. running at 200 r. p. m., built by Singrun Bros., of Epinal, France. Two three-phase alternators, with exciters, switchboards, etc., are required. Five other alternators of 900-hp each are in contemplation. The number of periods is placed at 50 per second and the electromotive force at 5000 volts minimum. Plans were requested not later, if possible, than January 30, addressed to the director of the company, El Porvenir de Zamora, and the first two alternators, etc., should be delivered at Zamora by September 30. Full details are given of the conditions.

WESTINGHOUSE APPARATUS.—It is stated that the Easton (Pa.) Power Company has placed an order with the Westinghouse Electric Manufacturing Company for $150,000 of electrical machinery and will put in an additional 800-hp of steam plant.

POWER PLANT FOR LONDON.—Mr. C. J. Goldmark, the consulting electrical and mechanical engineer of 29 Broadway, New

York city, is preparing plans and specifications for the power plant of a large industrial establishment which is to be erected in the vicinity of London, England, by Dutch capitalists, for a purpose not yet stated. The total capacity of the plant will be between 900 and 1000 hp. The buildings will cover about four acres of ground. There will be installed a complete electric transmission system with direct-connected engines and generators and electric motors. Mr. Goldmark was abroad for several months last summer making a careful study of the special needs of the plant under consideration, and also in that connection studied the latest engineering developments in Germany, France, Italy and Switzerland. He expects to go abroad again this summer to close contracts for all the work connected with the plant. It would seem that much of the apparatus might well be supplied from this country.

TROLLEYS FOR ENGLAND.—Mr. A. K. Baylor, recently manager of the railroad department of the British Thomson-Houston Company, who has been in the United States for the last two months in the interests of the London United, Bristol & Isle of Thanet Tramway Companies, sailed on Jan. 16 for England by the American liner St. Paul. Before his departure, Mr. Baylor said to a representative of the *Commercial*: "Of the $5,500,000 which it will cost the London, Bristol and Isle of Thanet Companies for equipment, certainly 90 per cent. will find its way into American pockets. During my stay here I have ordered equipment to the value of $250,000, which would have been tenfold had I been able to get deliveries. I shall return in about three months, when I hope to make further contracts." In talking of the prospect of electric traction in England, Mr. Baylor said that the South African war had caused a complete stoppage of important deals like the Manchester, Liverpool, Leeds and other large corporation work. The electrical schemes hung up involve about $50,000,000, and when they are put through fully $25,000,000 worth of material and equipment will be purchased in the United States.

LIGHTING IN SIAM.—A consular report, issued Jan. 24, says: There is an 8000-light (incandescent) central station in Bangkok which was purchased in 1890 from the English Brush Company by a Siamese Company, for the purpose of lighting the King's palace and for the use of the public. The plant was not operated until 1894, as the company met with financial difficulties, and finally it was turned over to Mr. L. E. Bennett, an American engineer, under a twenty-year exclusive franchise to furnish light for the Government and the public. Since that time it has been operated fairly well by an American syndicate. This plant, which is at present valued at $200,000 in United States currency, has recently been sold to a Danish company called the Siam Electricity Company, Ltd., and will be extended and improved. Most of the supplies for these works have been purchased in Europe, but very recently several orders have been placed in America.

WESTERN AUSTRALIA.—The firm of J. G. White & Co. have large contracts in hand for the Kalgoorlie Electric Power Company, Western Australia, and their W. E. Cooke, who has been studying the question on the ground, was recently in New York to assist in defining the situation and placing contracts. The conditions are quite extraordinary. The gold deposits are rich, but water is scarce, rain falling once or twice in three or four years. Coal has to be carried four or five hundred miles. It was at first proposed to use gas engines to drive the generators, but that plan has been abandoned for some time. The first generators to be put in will be units of 1200 to 1500 hp and the initial total capacity will be about 4000 hp. Current will be distributed over a wide area for all gold mining purposes, and the prices readily obtainable would suggest great possibilities of profit in the scheme.

FUSES IN RUSSIA.—Mr. A. Joseph, Glasovaia Oulitza, Loge 4, St. Petersburg, addresses us inquiring as to fuses used in this country on currents of high voltage, such as will cut the circuit immediately without retaining an arc. We shall be glad if any of our readers interested in the supply of such detail apparatus will communicate with Mr. Joseph at once. He says: "We have for the last year and a half laid here in St. Petersburg over 300 miles of cable for lighting and power transmission purposes. We have built up a central station containing seven alternators of 1000-hp each, which deliver current into the city at a pressure of 3000 volts. The whole system works admirably and the only trouble we get is from the fuses that cut out a cable or system of cables when a fault occurs somewhere. They retain an arc for quite a considerable time, and that produces undesirable results."

UNIFORM TERMS.—The secretary of a leading concern in the manufacture of electrical supplies writes us an urgent letter in favor of the quotation of uniform terms by the electrical trade. At present no such uniformity prevails, and the results of such uncertainty are injurious. Our esteemed correspondent writes in regard to this question: "My idea is to have all the electrical manufacturers quote the same terms, i. e., have them either quote 30 days net with no cash discount, or 60 days with 2 per cent. for cash in 10 days. Of course, the shorter terms would be more desirable, but it is a question if they could be enforced. If uniform terms were universally given, I think the whole electrical trade would be benefited." We shall be glad to hear from any other of our commercial readers on this subject.

THE ALBANY & HUDSON RAILWAY & POWER CO. have placed the contract with the Berlin Iron Bridge Company, of East Berlin, Conn., for their power house and the several bridges required for the extension of their line from Albany to Hudson, N. Y. The line will require nine spans of plate girder bridges, varying in length from 30 feet to 65 feet, with a viaduct over the tracks of the Boston & Albany R. R. and the New York Central and Hudson River R. R. This viaduct will require something over 1000 tons, it being 2000 feet long. The span over the Boston & Albany R. R. is 175 feet in length, pin-connected, and that over the New York Central & Hudson River R. R. is over 200 feet in length. The work is to be completed in the early spring.

FERRACUTE MACHINERY.—The Ferracute Machine Co., of Bridgeton, N. J., has shipped a carload of fourteen presses, weighing over 50,000 pounds, and motor, driving machinery, etc., to the Paris Exposition. About half of it will be placed in their space in the Main Exposition Building, and the other half in the Machinery Annex, at Vincennes. They will also, in about a month from now, ship a final carload, part of which will go in each building, some of it being special machinery for coining, etc. The Vincennes Building for American machinery, described lately in these pages, was started, it is said, largely upon the initiative of Mr. F. F. Smith, the secretary of the Ferracute Co.

TO BUILD ELECTRIC CARS IN LONDON.—It is reported from St. Louis, Mo., that the St. Louis Car Works will soon establish a branch in London, England, at a cost of $100,000. The company, it is stated, already has a branch in Berlin. A. K. Baylor, lately in New York in the interests of the London, United Bristol and Isle of Thanet tramways, has placed an initial order with the St. Louis Company for fifty cars. This will be followed by an order for several hundred cars. To avoid delay and extra expense for freight, as well as to prevent the congestion in the plant in America, is the reason given for establishing the London branch.

METERING CURRENT.—In the fall of 1898 the Boston Edison Company ordered some 1500 Wright indicators, and applied the system to a large portion of their business. The natural result has followed, as is shown by an order just placed for 2040 meters of various sizes. The Boston Edison Company is earning and paying, practically, 8 per cent. on its whole investment (stocks and bonds averaged) as good if not a better record for its stockholders as any other company can show in the United States. That such a company, after a thorough trial of the system should then place an order for over 2000 Wright meters is a fact that carries great significance.

NEWCASTLE, ENGLAND, has at the present time a population of several hundred thousand industrious inhabitants and only 19 miles of horse street railway. It is now proposed to put in an extensive trolley system, and with this end in view Mr. A. E. Le Rossignol, resident electrical engineer of the Newcastle-on-Tyne corporation, is now in this country making a study of various roads operating under the conditions that will apply directly to the new work. As in so many other instances, it is hoped and believed that orders for apparatus will be placed in this country at no distant date.

INGERSOLL-SERGEANT DRILL.—Mr. John J. Swann, representative of the Ingersoll-Sergeant Drill Co., sailed for France on the American liner, St. Paul, on Jan. 17. He is to superintend the installation of the compressed air power plant in the American section of the Paris Exposition, and he will also have charge of that company's interests during the continuance of the exposition. He will also do some editorial work for *Engineering News*, to whose staff he was formerly attached. The exhibit of American compressed air apparatus at Paris is expected to be very fine and comprehensive.

THE METROPOLITAN ELECTRIC SUPPLY CO., of London, England, one of the largest electrical concerns in the British Empire, whose plant is described in this issue, has recently placed an order for four 90-gallon Cross oil filters, manufactured by the Burt Manufacturing Company, of Akron, O. These are for use in their stations. The British Government has also been a large buyer of these goods during the past year, notwithstanding the fact that the English makes are both plentiful and cheap. Thomas A. Edison has also just placed a large duplicate order for Cross filters.

THE CLING-SURFACE MFG. CO., of Buffalo, N. Y., report steadily growing business, with not only large domestic sales, but recent shipments to Mexico, Japan and Australia. The best proof of the merit of Cling-Surface is the large percentage of repeated orders.

Special Correspondence.

NEW YORK NOTES.

New York, Jan. 30, 1900.

MR. T. G. MEACHEM, of the New Process Raw Hide Company, Syracuse, N. Y., was in town last week, attending the Automobile Show. There are several vehicles in the show carrying their pinions, and hundreds all over the country are proving them to be very satisfactory in the new work.

POSTAL FACILITIES.—The Merchants' Association in its plea for a new post office for New York mentions the striking fact that the local post office in nine years has earned $66,000,000, spent $26,000,000, and thus made a profit for the government of $40,000,000. Over 400,000,000 letters from the other parts of the country to New York are delayed when they get here by the absence of proper accommodations for handling.

AUTOMOBILE AMBULANCE.—Mr. Edward Kelly has presented to St. Vincent's Hospital an electric automobile ambulance. The vehicle, which is now ready for service, cost $3000, and weighs, ready for use, two tons. The batteries have a storage capacity sufficient to propel the vehicle 14 hours at a speed of nine miles an hour. The gear is noiseless, and the wheels have solid rubber tires. It is said to be the speediest and most complete ambulance ever constructed.

ROCHESTER, N. Y.—A decision has been handed down by Justice Davy, of the Supreme Court, in the case of the Bell Telephone Company against the city of Rochester and others, by which he declines to allow the Bell Company to file a supplemental complaint. The action was brought by the Bell Company to set aside a resolution adopted by the common council providing that the Bell Company should allow other corporations to use the Bell Company's conduits. Another motion was made by Attorney Barhite for the Bell Company to vacate an injunction obtained by the city restraining the building of conduits by the company on the ground that it is a public nuisance. Assistant Corporation Counsel Stull argued against the motion. Decision was reserved. The Home Telephone Company, which was recently organized to provide competition for the Bell Company in Rochester, is supported by several of the leading financiers in Rochester, and funds are ready to build the system as soon as the litigation with the Bell Company over the right to use the city's subways is ended.

NEW ENGLAND NOTES.

Boston, Mass., Jan. 27, 1900.

BOSTON ELEVATED APPOINTMENTS.—C. S. Sargeant, of the Boston Elevated Railroad, has been promoted to the office of first vice-president. This has been done on the retirement of President Gaston and the elevation of Gen. W. A. Bancroft from the office of general manager to that of president.

THE B. F. STURTEVANT COMPANY have received an unsolicited letter from James McKinney & Son, of Albany, N. Y., relative to their experience with Sturtevant blowers. When the firm was established in 1857 the first Sturtevant blower for cupola purposes used in Albany was put in by it. In 1872 the second blower of that make, but of much larger capacity, was put in, and has given continuous good service ever since. Taking up the question of induced draft for its boiler the company turned to the Sturtevant blower for the third time, and did not consider any other make.

PENNSYLVANIA AND OHIO NOTES.

Philadelphia, Pa., Jan. 27, 1900.

DOYLESTOWN, PA.—It is stated that extensive additions will be made to the power houses and new car barns constructed for the Doylestown Railroad Company. This will be necessary owing to the proposed extensions to the line, which will connect at Germantown Junction and extend to Hatboro, Abington and Weldon, Pa.

INCREASING TELEPHONE CAPITAL.—The Bell Telephone Company, of Philadelphia, is again about to increase its capital in order to meet the extensive development of its lines and to improve its service generally. In 1897 the capital of the company was $560,000. It has since grown to $4,000,000 and the latest proposition is to increase it to $6,000,000. With this object in view the directors of the company have called a stockholders' meeting for March 20, at which time the measure will be carried through or defeated. Under the present capitalization of $4,000,000 the company pays 8 per cent. on $50, the par value.

Pittsburg, Pa., Jan. 27, 1900.

MR. ARTHUR G. SCHULTZ, an electrical engineer of St Petersburg, Russia, has been a visitor at the works of the Westinghouse Electric & Manufacturing Company at East Pittsburg.

MR. J. H. SPANGLER, of this city, has invented an electric switch, which is now being tested by the Consolidated Traction Company. The device is used for switching cars from one track to another and it can be operated by the motorman with the greatest ease.

THE BROTHERHOOD OF ELECTRICAL WORKERS has made a demand upon all employers of electrical workers requesting that all foremen, cablemen, linemen and switchmen be forced into the union. It is likely, however, that this demand will be refused and a strike is imminent.

THE AMERICAN ELECTRIC SWITCH COMPANY, of this city, has applied for a charter. The incorporators are Messrs. John H. Spangler, Charles Sohn, E. G. Sohn, Ernest Gawthrop, William M. Galbraith, of this city. The company intends to manufacture and exploit the Spangler electric street car switch.

THE STANDARD UNDERGROUND CABLE COMPANY.—The annual meeting of the Standard Underground Cable Company, of this city, was held on Tuesday at the offices in the Westinghouse Building, and the report of the company's business for the last year reflected to a wonderful extent the prosperity of the country. During the year the stockholders received $400,000 in stock dividends and $125,000 in regular dividends, and yet at the end of the year the company had a surplus of $207,622.57. A total business of $1,944,053.39 was done during the year, representing an increase of nearly 60 per cent. over the great business of 1898. The company began the new year with over $500,000 worth of orders booked and in the last three weeks they have taken $200,000 more. Some of the most important orders came from the Bell Telephone Company, the Pittsburg & Allegheny Telephone Company, the Delaware & Atlantic Telephone Company of Atlantic City and the Atlantic Coast Telephone Company. The company is now erecting two branch factories, one at Oakland, Cal., and another at Perth Amboy, N. J. The following officers and board of directors were elected: Mark W. Watson, president; Joseph W. Marsh, vice-president and general manager; Frank A. Rinehart, secretary and treasurer; Charles M. Hagan, auditor; Mark W. Watson, James H. Willock, George B. Hill, Robert Pitcairn, John B. Jackson, J. N. Davidson and J. W. Marsh.

Cincinnati, Ohio, Jan. 27, 1900.

MR. JOHN T. McROY'S Ohio representative, Mr. Pixley, is in the city calling on the electrical people.

THE CREAGHEAD ENGINEERING COMPANY has just completed the installation of an electric light plant in the new works of the Dietz Machine Tool Company.

MANAGER McCALLUM, of the Electric Railway Equipment Company, reports that the company is bidding on considerable foreign work, and that the business on hand warrants them in looking about for more room.

THE CARLISLE & FINCH COMPANY reports inquiries increasing from all parts of the country for searchlight equipment. The firm is as yet unsuccessful in securing another location. Fear of the February floods in the river is the cause for the desire to move.

REDUCTION OF TELEPHONE RATES.—It is reported that nearly a thousand applications for service have been received by the local telephone company since the reduction in rates Jan. 1. The officers of the company have advertised for 50 bright young men to learn the business of installing telephones.

THE LAWTON-BEATTIE COMPANY have put in a number of motors and generators this week. One of 45-hp, for electric transmission, has just been installed in the extensive addition recently finished by the R. K. Le Blond Machine Tool Company, of the East End.

PRESIDENT A. F. MAISH, of the Electrical Appliance Company, announces brand-new outputs this week of the company's latest desk telephone, electric call bells and receiver. This company is organized for the making and introduction of special electric contrivances, and has a large number under way in addition to those named.

THE BULLOCK ELECTRIC MANUFACTURING COMPANY shipped to-day four carloads of equipment to Oakland, Cal. The material constituting the component parts of an 800-kw generator for power transmission is billed to the Oakland Transit Company, which is building extensive additions to its power house. President George Bullock left Friday night for New York, where he will spend 10 days at the offices of his concern.

THE CINCINNATI EDISON ELECTRIC COMPANY'S new uptown office building will be erected on a lot 25 feet 10 inches front by 117 deep in the most conspicuous spot on Government Square, opposite the Federal Building. The structure will be six stories in height and of fireproof construction throughout, with basement 132 feet in length, where will be installed the storage battery to take care of the city's central service. Manager White expects to see work commence within a few weeks.

JUDGE THOMPSON, of the United States Courts here, has made an order for the sale of the Ironton Electric Light & Railway Company. The company has been in the hands of a receiver for some time. William D. James, of Cincinnati, was appointed special master. No bid under $60,000 is to be considered. The sale is conditional upon the company failing to pay up within 10 days the outstanding claims against it. This includes some receiver's certificates and overdue coupon interest, amounting to about $41,000.

MR. W. F. WHITE, the new general manager of the Cincinnati Edison Electric Company, has impressed Cincinnatians in the few weeks he has been at the helm of that institution as a man of much business sagacity and aggressiveness of the right sort. One of the most agreeable happenings to citizens since his assumption of the management has been the promulgation of a general reduction in rates of service to consumers of light and power. Circulars recently issued give full information, enabling the uninitiated consumer to figure what his service will cost. The reduced rates apply on all January bills. The base rate on lighting service is reduced from 15 cents to 10 cents per kilowatt hour, and includes a very liberal system of discounts. Manager White said that the company is contemplating making a number of improvements in the new plant at Plum and Canal streets. New dynamos and engines are to be installed, but these features of improvement will not be available until next fall. Mr. White will remove his family here from Omaha, Neb., within a few weeks.

Cleveland, Ohio, Jan. 27, 1900.

AKRON, OHIO.—The Central Union Telephone Company commenced work on an underground system in the business portion of the city. The company fought for three years before it succeeded in getting the right to do the work.

THE UNITED STATES CONSTRUCTION COMPANY, of Cleveland, has been given a contract by Cleveland parties to build an electric railway from Kokomo to Indianapolis, Ind. It is stated that the road will cost $600,000.

RAILWAY FRANCHISES.—The county commissioners of Licking and Franklin counties have granted franchises to the Columbus, Buckeye Lake & Newark Traction Company. The line will be built from Newark to the Columbus city line.

EVERY CAR MUST HAVE A CONDUCTOR.—The House of Representatives in session at Columbus has passed a bill, providing that all street cars operated in Ohio shall be furnished with conductor as well as motorman. The bill was proposed through the efforts of Dayton street railway men. The cars in that city are operated with motorman only.

A SYNDICATE composed of Harry C. Engle, H. W. Reeves, Henry Fitzpatrick and Charles E. Deens, of Beaver, Pa., have applied in Ohio for a charter for a new company to build an electric line from Beaver to East Liverpool, Ohio. The line will connect with the Beaver Valley Traction Company's lines at Vanport and will extend down the Ohio River to Wellsville, Ohio.

RESIGNED.—Mr. J. C. Mengensdorf, general passenger agent for the Akron, Bedford & Cleveland and the Cleveland, Painesville & Eastern Electric Railway companies, has resigned to go into the theatre business. The office has been abolished as the Akron, Bedford & Cleveland Railway is now a part of the Northern Ohio Traction Company and has removed its general offices from Cleveland to Akron.

STRIKERS RETURN TO WORK.—About 50 employees of the Orient Electrical Company, at Youngstown, went on a strike last Tuesday over a change in wages. Manager Esterbrook claimed the change was but an equalization of the prices paid in the various departments, and that two-thirds of the employees had been increased since the change in management some time ago. Thursday the strikers went back to work with but one or two exceptions.

INDEPENDENT TELEPHONE INTERESTS.—The interstate traffic committee of the independent telephone companies west of Pittsburg, which has been in session in Cleveland for some time, last Friday organized the United Press Company. The new corporation will have a capital stock of $10,000, and the headquarters will be in Columbus. Its object will be to effect a combination of long distance telephone companies, with a view to conveying news to newspapers.

MUNICIPAL LIGHTING IN CLEVELAND.—The committee appointed by the Cleveland city council to look into the advisability of municipal lighting, made a report last Friday night. It was shown several hundred cities in the country have municipal lighting plants, and a tabulated list of 25 leading cities showed that every one secured their light from 20 to 200 per cent. cheaper than Cleveland. It is very probable that as a result of these investigations the council will take steps to purchase a municipal plant.

THE TOLEDO & BAY POINT ELECTRIC RAILWAY COMPANY has been organized to build an electric line from Toledo to Bay Point, on Lake Erie, where an extensive summer resort is to be located. The organization was effected last week, with the following officials: Fred A. A. Park, president; Dr. W. G. Gardner, vice-president; H. S. Landis, secretary-treasurer, and J. A. Dawson, general manager. The cost of constructing the road is estimated at $200,000, and $100,000 will be spent in improving Bay Point.

THE NORTHERN OHIO TRACTION COMPANY.—The annual business meeting of the Northern Ohio Traction Company was held in Akron last Saturday. The officers elected were: H. A. Everett, president; Will Christy, vice-president; L. E. Beilstein, general superintendent; C. F. Moore, secretary; J. R. Nutt, treasurer; directors, H. A. Everett, Will Christy, L. E. Beilstein, E. W. Moore, Charles Wasson and B. Mahler. It was decided to double-track the Akron, Bedford & Cleveland line between Akron and Cleveland. Considerable additional equipment is to be purchased.

ELECTIONS OF OFFICERS.—A number of electric railways throughout the state held their annual meetings and elected officers the past two weeks. At Springfield the Dayton, Springfield & Urbana Electric Railway Company elected John H. Harshman, president; Frederick Colburn, vice-president, and George J. Webb, secretary. The above, together with F. J. Green, C. A. Alderman and A. E. Appleyard, will constitute the board of directors. At Dayton the Dayton Traction Company elected Frank N. Wilcox, Cleveland, president; J. S. McMahon, Dayton, vice-president; C. C. Collister, Cleveland, secretary and treasurer, and E. G. Tillotson, Cleveland, and Warren M. Bicknel, Middletown, directors. At Cleveland the Cleveland & Lorain Electric Railway Company elected the following directors: B. Mahler, H. A. Everett, E. W. Moore, C. H. Stewart, W. J. Gawne, J. B. Hanna and J. B. Hoge. At Hamilton the Cincinnati & Miami Valley Traction Company elected M. J. Mandelbaum, president; Peter Schwab, vice-president; F. T. Pomeroy, secretary; Will Christy, treasurer, and J. A. McMahon, director.

WESTERN NOTES.

Chicago, Ill., Jan. 27, 1900.

MESSRS. WILLIAM H. ECKERT and Willard M. Miner, of the Knickerbocker Telephone Company, New York City, are visiting Chicago this week.

THE TELEPHONE CONSOLIDATION IN MICHIGAN.—Referring to the recent consolidation of telephone interests in Michigan, a Chicago paper says that the independent telephone movement in the United States has recived a setback in the transfer of the rights of the Detroit Telephone Company and the New State Telephone Company, of Michigan, to the Bell Telephone Company. These companies formed the nucleus of the independent movement and their sale means the transfer of nearly all the independent companies to the Bell Company.

Milwaukee, Wis., Jan. 27, 1900.

THE WISCONSIN TELEPHONE COMPANY is installing a system at Hartland, Wis.

MUNICIPAL ELECTRIC LIGHT PLANT VOTED.—A proposition to construct a municipal electric lighting plant at La Crosse was carried at a recent election.

PAWLING & HARNISCHFEGE, manufacturers of electric cranes, recently moved into their new shop building. They state that the demand for their electric cranes is large. They are supplying cranes to all parts of the world.

THE FINK FEHRLIN CHEMICAL COMPANY is building a large factory at Cudahy, Wis. The machinery will be electrically driven. Mr. George F. Rohn has the contract for the complete electrical equipment. The contract includes two 40-kw, 230-volt direct current belted generators; two 10-hp, two 4-hp, five 3-hp and three 1-hp, 220-volt direct current motors. The generators and motors will be of the Milwaukee Electric Company's make. Four hundred and twenty-five incandescent lamps will be wired up. A complete and modern switchboard will also be furnished.

Minneapolis, Jan. 26, 1900.

A NEW TELEPHONE COMPANY is being organized in Stillwater. The officials state that it is the idea of the company to form a mutual company by permitting subscribers to take stock in the enterprise. Business telephones will be furnished at $2 per month.

THE WESTERN UNION TELEGRAPH COMPANY has recently installed 16 Crocker-Wheeler motor-generators in its operating rooms at Hennepin and Third streets, this city. The new plant displaces about 6000 standard gravity cells. There are 11 ½-hp, 2 1¾-hp and 3 2½-hp machines, the motor sides of which are connected by a double throw switch to a 220-volt circuit of either the International Electric Company or the General Electric Company. The generators are compound wound, and the pressures of the different machines range from 7 to 340 volts. Each unit is equipped with an automatic starting box.

Indianapolis, Ind., Jan. 26, 1900.

NEW STREET CAR SHOPS.—The Dohner Foundry Company, of Cleveland, which manufactures trucks for street cars, has decided, it is stated, to locate in Logansport. The plant when established will manufacture street cars complete, and expects to be in operation in sixty days.

A NEW AUTOMOBILE PLANT.—D. M. Parry & Co., of Indianapolis, will soon begin the manufacture of automobiles on an extensive scale. New buildings will be erected at an outlay of $500,000. The firm will make ambulances, prison vans, patrol wagons, platform wagons and runabouts.

CONTRACT LET.—The contract to construct the Logansport and Kendalville electric line has been let to an Eastern contractor, work to begin at Warsaw and proceed in both directions. An alternating current system will be put in, and Warsaw selected as the location for the power plant.

A COSTLY FIRE.—The entire plant, machinery and car barns of the Union Traction Company, including all the cars save one, at Muncie, was burned on Jan. 22. The loss will exceed $100,000, with $50,000 insurance, and will retard the operation of the company's entire interurban system at least three months.

MUNICIPAL CONTROL UNPROFITABLE.—The clerk of the Logansport electric light plant submitted his annual report showing that the plant had been operated at a loss of $7000 during the year. The plant is a model one, and has been inspected by authorities of other cities, imbued with the municipal control fever.

A TELEPHONE DIVIDEND DECLARED.—The Home Telephone Company, at Wabash, with 350 subscribers, notwithstanding the competition of the Central Union, has declared a semi-annual dividend of 3 per cent., and paid a large amount of its debts. The capital stock of the company is $10,000, and not a single share is on the market.

AN INDUSTRIAL ENTERPRISE.—A company has been organized in Indianapolis to build a commodious factory building, eight stories high, to accommodate manufacturers of many kinds and furnish them with electric power, heat and light. Plans have been submitted and the building, it is said, will be the largest of the kind in the country.

THE MARION TRANSIT COMPANY, the new electric line which will ultimately give entry to Marion for the cars of the Indiana & Ohio electric lines coming by way of Fort Wayne and Huntington, started its cars on Jan. 14, and is ready for business. The Marion Transit Company is composed of Marion business men of push and sagacity.

AN ALLEGED INSURANCE HAZARD.—Business men of Richmond are preparing to inaugurate a fight against the fire insurance companies that are identified with the local board of underwriters, because an additional 1 per cent. is charged if the holder of the policy lights his store or residence by electricity furnished by the street railway company. The Light, Heat & Power Company, of Richmond, has a monopoly on the lighting business, inasmuch as it owns both the gas and electric light plants. The rates for commercial service are exceedingly high and consumers must either submit or procure the service of the street car company. The insurance companies claim that the street railway company's light service is extra hazardous, because the voltage fluctuates.

St. Louis, Mo., Jan. 26, 1900.

TWO NEW POSTAL STREET CARS will be put in service on Broadway from Baden to Jefferson Barracks Feb. 1, and each will make seven round trips a day gathering and distributing mail en route, going and coming.

THE TIPTON TELEPHONE COMPANY, of Tipton, Mo., filed articles of incorporation with the secretary of state Jan. 17. The capital stock is $1400. The incorporators are J. M. Boyd, J. W. Marsh, P. J. Weber and others.

CHEAPER LIGHT FOR RESIDENCES.—The Missouri Edison Electric Company has announced a reduction in the prices for electricity for lighting purposes in residences. In the past a flat rate of 1¼c. per hour for each 16-cp lamp has been the uniform price for residences. On the new scale a rate of one-half the present rate will be charged on any excess of over 50c. per room per month, figured on all rooms in the residence.

KINLOCH TELEPHONE COMPANY.—At the annual meeting of the stockholders of the Kinloch Telephone Company, Jan. 22, the old board of directors was re-elected as follows: Sam M. Kennard, William F. Noltar, William D. Orthwein, Breckenridge Jones, Ellis Wainwright, Charles H. Turner,

Adolphus Busch, Julius S. Walsh, C. Marguard Forster, August Gehner, George J. Kobusch, C. K. Dickson Walsh, Hopkins J. Hanford. The directors will meet within two weeks to elect officers. The company now has over 6000 subscribers and the largest independent switchboard in the world in its exchange.

IMPERIAL ELECTRIC DEAL.—It is reported that the men who are back of the United Railways' deal have secured control of the Imperial Light & Power Company, and that this company will furnish power for the street railways east of Eighteenth Street and north of Chouteau Avenue. A new system will be adopted by the Imperial Company, by means of which all surplus energy from the dynamos will be stored in accumulators during the day, and the power so accumulated can be used at night for lighting. In like manner all surplus energy at night can be stored for use when the traffic is greatest during the day time. It is said that the Imperial Company recently asked for prices on a complete equipment of dynamos and other machinery for a power plant, but both the General Electric Company and the Westinghouse Company replied that the Missouri Edison Electric Company is the sole licensee for the use of their machinery in St. Louis and arrangements would have to be made through them. This will dispose of the Imperial Electric Company as to the city lighting. The securing of the Imperial Electric Company by the United Railways Company is a step toward the consolidation of all the lighting, power, conduit and street railways under one management.

San Francisco, Cal., Jan. 20, 1900.

THE WHEELER COUNTY TELEPHONE COMPANY, of Oregon, was recently granted rights of way over all of the county roads.

CONSOLIDATION IN PALO ALTO.—The lighting companies in Palo Alto, Cal., are to be consolidated, it is said, under the management of Jos. E. Green.

MR. S. F. BARBOUR, of the General Electric Company's Pacific Coast District Agency, recently returned to San Francisco after spending two months in the eastern states.

THE SAN FRANCISCO GAS & ELECTRIC COMPANY has declared a dividend of 33 cents per share on the issued capital stock of the company, pay able on and after Feb. 1, 1900.

ELECTRIC POWER IN MACHINE SHOPS.—Electric motors are to be installed for operating the machinery of the Santa Fe Railroad Company's car and machine shops, in San Bernardino, Cal.

THE CONSUMERS' ELECTRICAL ASSOCIATION is the name under which W. S. Hyde, H. N. Sessions and W. G. Thompson, Jr., have opened up in business at 524 Sutter Street, San Francisco.

RANCHERS' TELEPHONE LINE.—Wasco County, Ore., ranchers and stockmen have organized a company to build a telephone line, which will connect their farms. Among the points to be reached are Antelope, Muddy, Ashwood and Hay Creek.

JOHN M. KLEIN, of the John M. Klein Electrical Works, San Francisco, is behind the newly organized Alameda County Telegraph-Telephone Company. The company has applied for a 50 years' franchise and offers the city offices of Alameda, Cal., free telephone service.

THE CAPE NOME ELECTRIC LIGHT & TELEPHONE COMPANY was recently incorporated by David Rich, Eugene Folger, C. S. Benedict, Edward Holland and Charles S. Rosener. The capital stock is placed at $150,000. Cape Nome, Alaska, will be the business location.

MR. L. P. MATTHEWS, of Cleveland, Ohio, who returned several weeks ago from Hawaii, has gone east on business connected with the proposed electric railway from Hilo to Kahala, H. I. A Cleveland syndicate, which Mr. Matthews represents, expects to build the road, which will be 130 miles in length when fully completed.

THE ELECTRIC LOG-RECORDING COMPANY was recently incorporated, with San Francisco as the principal place of business. It will deal in electrical appliances, log-recorders, etc. The incorporators are F. M. Munger, L. W. Storror, L. T. Jones, J. Mel and W. B. Armstrong, all of San Francisco. Capital stock, $30,000, all subscribed.

THE GENERAL SUPPLY COMPANY, which was recently incorporated in this city by P. A. Reger, M. F. Pixley, G. E. Whittaker, A. W. Sisson and E. Hessler, has commenced business in the large store at 537 Mission Street. Mr. Parry A. Reger is manager of the electrical and general supply business of the company, which has entered the field with ample capital.

THE INDEPENDENT ELECTRIC LIGHT & POWER COMPANY, San Francisco, is making rapid progress in the construction of its main electric generating station and substations. Conduits have been laid in a number of streets and cables are being drawn in at a rapid rate. The Standard Underground Cable Company's works in Oakland, Cal., are insulating 4000 feet of cable per day for the Independent Company's mains. A large force of men is excavating for conduits in the principal streets of the business centre of the city. Charles C. Moore & Co. are now instaling the Babcock & Wilcox boilers, with a capacity of 12,000-hp in the main power house.

SOUTHERN NOTES.

Louisville, Ky., Jan. 27, 1900.

THE TEXAS TELEPHONE COMPANY, which has its general offices at Austin, has been making some important extensions of its lines recently. This system now connects Austin, Llano, Burnet, Lampasas, Lometa, San Saba, Mason, Fredericksburg, Comfort and numerous intermediate points. The work of construction is in charge of Mr. C. R. Pengilly.

RAILWAY EMPLOYEES.—The 600 employees of the Louisville street car lines have presented demands to their employers for an increase of wages from 16½ to 20 cents an hour, recognition of the union, the right to arbitrate cases of the removal of employees for various offences; the right to buy uniforms in the open market, and a better system of collection of cash fares, a strike being threatened in case of refusal. The Central Labor Union, embracing all labor of the city, has decided to support the street car men, and if the demands of the latter are not granted will make a general fight on the companies to compel them to provide conductors for all cars.

CANADIAN NOTES.

Ottawa, Ont., Jan. 27, 1900.

THE MONTREAL COTTON COMPANY, of Valleyfield, Que., is pushing the extension to its new power house, and expects that by the first of May next, it will be completed and the new 1200-kw generator in operation. An interesting feature of this installation, which will be the largest industrial electric plant in the world, is contained in the switchboard arrangement. This will consist of a series of Vermont blue marble panels, 36 inches wide by 88 inches high, upon which will be mounted the necessary switches for controlling the motor circuits, and all instruments for controlling the generators and exciters. There will be used for the present equipment 12 feeder panels and six generator panels. The entire board, as covered by present orders, will be 54 feet long, and when completed will present an imposing appearance.

CHAMBLY POWER FOR THE MONTREAL RAILWAY.—It is understood that the Montreal Electric Street Railway Company is negotiating with the Chambly Water & Power Company for the supply of electric power in the operation of the railway company's system, and that this corporation will acquire a good-sized lump of the Chambly Company's stock. It is also said that the Royal Electric Company, of Montreal, will purchase an extensive interest in the same company. The fact is well known that the Montreal Street Railway will take a good share—if not all—of its power from the electric works at Chambly, and it is generally believed that between the street railway and the Royal Electric Company two consumers of electricity will be able to use up about all the power that the Chambly Company can furnish. The officials of the different companies, while not denying that there are plans on foot, refuse to say anything at the present time. There is promise, however, that soon a big electric project will be launched which will make the average Montreal financier open his eyes.

ELECTRICAL INDUSTRIES IN CANADA have fully shared in the general prosperity that is now felt throughout the Dominion. It is stated that the leading electrical manufacturing and supply companies report that the volume of their business for 1899 exceeded by upward of 75 per cent. the business done during 1898. More than half of the output of these companies was applied to the extension and improvement of existing plants, the bulk of the machinery sold being for lighting and power purposes. Many electric lighting companies took advantage of the prosperous times to discard old-type machinery and replace the same with new apparatus of higher efficiency. Improvement and development have been quite as marked in the commercial as in the mechanical field. The business done has been so large and so profitable that the stock of the two leading manufacturing companies in the Dominion has risen 50 points during the year, and further advances are predicted. The workshops of the electrical manufactories are said to be crowded with orders to such an extent that no promise of delivery at a specified time can be made, and prices are firmly maintained. The outlook for the current year is everywhere regarded as most promising. It is estimated that during 1900 nearly 100 miles of electric railway will be built out of the city of Hamilton, Ont., alone. Canada has already in operation the largest generators in the world, and has also some of the largest electrical enterprises. The limit in this direction has not yet been reached, and with continued commercial and industrial prosperity, electrical enterprise will show greater expansion in the near future. This new medium of power transmission has made possible the utilizing of Canada's many gigantic water powers, and the possession of this cheap and abundant energy must tell in the competitive race of industrial development.

THE SHAWINIGAN WATER POWER.—Mr. T. C. Frenyear, manager of the Buffalo office of the Westinghouse Electric & Manufacturing Company, of Pittsburg, Pa., was recently in Montreal to complete arrangements for the installation of two powerful generators at the plant of the Shawinigan Water & Power Company, on the St. Maurice River, Que. The Shawinigan Company's power house will have two generators of a normal capacity of 5000-hp, and a maximum capacity of 7500-hp each. They will be unique in Canada, according to Mr. Frenyear's belief, and the fact that the province of Quebec is to have them speaks highly for the future of this section of the Dominion, where industrial progress, up to the present day, has been said to have dragged. The Westinghouse Company has its hands full of paying business nowadays. Its English branch is erecting an immense new plant on its 40-acre tract of land near Manchester, England. The French branch, with a large shop at Le Havre, is doing finely. Even in Canada the company is filling important orders. Apart from the works at Shawinigan, it is setting up two 1000-hp generators for the Jacques Cartier Power Company, near the city of Quebec, and a 5000-hp generator for the inside needs of the Pittsburg Reduction Company, which is about to erect a large aluminum factory at Shawinigan, taking its motive power from the Shawinigan Company, will also be put up by the Westinghouse people. Each of the two alternating current generators at the Shawinigan Falls will weigh 200,000 pounds, and will be coupled directly to the water wheel shaft. They are of the revolving field type. As to the capacity of the original power house, it may be raised to a 30,000-hp. Besides the aluminum factory, a calcium carbide factory will soon be in process of erection, and a whole city area has been already surveyed and plotted out for the workmen of these immense plants. There is also a scheme on foot to erect a cotton mill at Three Rivers, Que., to be operated by electricity secured from the Shawinigan Falls. The Shawinigan Power Company has just placed a contract with the Cramps' Shipbuilding Company, of Philadelphia, for two water wheels of a 6000-hp, to be built at the shops of the late I. P. Morris Company.

ENGLISH NOTES.

London Office, ELECTRICAL WORLD AND ENGINEER, Jan. 20, 1900.

STEAM TURBINES.—It is interesting to note, though it has no particular electrical significance, that at a recent trial of a torpedo boat destroyer, fitted with Parson's steam turbine, a speed of 35½ knots per hour was attained. This is equal to a speed of about 41 miles an hour, and is the greatest speed ever yet attained by any boat.

PERTH COUNTY.—At a meeting of the Perth County Council it was intimated that a plan had been received with regard to a proposed scheme of electric light for Bridge of Allan and Dunblane. These are two small towns in Perthshire, Scotland, Bridge of Allan especially being a summer resort of visitors from Glasgow and Edinburgh.

THE CITY OF DUBLIN has up to the present time dealt with electric light on a somewhat limited scale. Having obtained an important addition to its borrowing power, the City Council have just resolved to carry out a comprehensive scheme of electric light and power submitted by Mr. Robert Hammond, of London, involving an expenditure of £254,000.

THE CORPORATION OF OLDHAM has applied for leave to borrow £36,000 for the purpose of paying for extensive additions to the electric lighting station. The electric lighting has been most satisfactory to the corporation, and with the completion of the present scheme the whole of the site of the present station would be built upon, and the corporation intends establishing a new station on the other side of the railway.

IN LONDON.—The work in connection of the electric lighting of Poplar is making satisfactory progress, and Mr. Blackman, the electrical engineer, reports that he hopes by May to have about 17 miles of mains laid, and by August, under ordinary circumstances, the principal thoroughfares in the district, including Bow Road, East India Dock Road, and Poplar High Street will be lit by electric light. Whitechapel is now considering an electric lighting scheme, which will cost about £60,000, although it has had, by means of temporary arrangements, electric light in the public streets since last Christmas. The temporary plant has a capacity of 400 kilowatts, some 31 miles of cable have been laid, and over 50 arc lamps been connected. The new central station is being built on the Whitechapel Road in the very heart of the district, and will be equipped like the Shoreditch scheme, with a dust destructor used for generating the steam from refuse.

MR. ARTHUR JAMES ARNOTT, the city electrical engineer of Melbourne, Australia, has just completed a six months' tour in England, America and on the Continent, for the purpose of inspecting the methods of electric lighting adopted in the most recent central stations in these countries, the best points of which it is his purpose to adopt in the new system for the capital city of Victoria. Mr. Arnott evidently does not think very highly of the electric lighting in England, but thinks American systems are wonderful. He states that the City of Melbourne has recently purchased three companies outright, which had been supplying about 50,000 incandescent lamps, and it is now the intention of the corporation to build a new station for taking care of this lighting and extensions. The system recommended is the low tension, continuous current three-wire system, with 230-volt lamps, within an area of a mile and a half from the station, the alternating high-tension system to be used beyond that area.

SOME SMALL PLANTS.—The towns of Malton, Norton and Pickering are all pushing forward proposals for the establishment of electric light. All three of them have had to depend upon gas up to the present time. The first annual meeting of Fleetwood & District Electric Light & Power Syndicate, Ltd., was held recently, at which a very satisfactory report was presented. The central station has not as yet been quite completed, but it was reported that all the mains had been laid, and that the engines and dynamos were in position, and it was expected that by March that they would be able to turn on the electric light. Leigh is the latest municipality to adopt electric light, the supply being turned on for the first time during the past week. The installation has cost over £10,000, and is on the three-wire system at a pressure of 440 volts. At present only the compulsory area under the act is lighted, but extensions are already projected. A committee meeting of town councilors are at present also considering the question of electric traction.

TOWN LIGHTING.—At a special meeting of Bridlington Town Council it was decided to forward a memorial to the Board of Trade asking for a provisional order for the electric lighting of Bridlington. Ilford is seeking to borrow £76,000 with which to build an electric light and electric tramway system. The Council has already a provisional order to light the town by electricity, and has obtained an Improvement Act, which enables it also to construct electric tramways. The City of Salford has passed a resolution through the town council for the expenditure of the following large sums by the electric lighting committee: £133,245, for a generating station; £159,256, for electric light mains, and £42,282, for underground and overhead tramway equipment. The Mayor of Wigan recently laid the foundation stone of the new power station in connection with the electrical undertaking of the Wigan Corporation. The proposals of the corporation involve an expenditure of £85,000 for electric lighting, and £40,000 on two lines of tramways, while the probable expenditure in the future will include the working of the tramways for the whole district, amounting to £300,000 or £400,000.

MALVERN is once more about to consider the question of spending £30,000 in establishing electric light in the town, and it is to be hoped that this time the scheme will go through, as it has been considering it for the past 10 years. The local board of the town secured a provisional order in 1890, and as nothing had been done the Board of Trade recently called them sharply to order, and advised them that if they did not put the provisional order into force by January of this year it would be withdrawn and power to supply electric light granted to private enterprise. A report has, therefore, been drawn up by a special committee, and the services of Mr. Robert Hammond secured, so that they will now have the best expert advice on the subject. Malvern is a health resort, and most other towns in England, such as Bath, Cheltenham, Harrowgate, Tunbridge Wells, and other famous towns where visitors resort for their health, have electric light, which undoubtedly proves a vast attraction to visitors who object to gas light or candle light in their rooms. Mr. Hammond has gone into the question thoroughly, and has refuted all the objections which can possibly be brought up, so that by another season Malvern will probably have the electric light to assist it in competing with other resorts.

MUNICIPAL TELEPHONE EXCHANGES.—As is well known, the greater portion of electric lighting and traction in this country is municipal; in other words, it is in the hands of the corporations. Municipalization seems to be carried to an absurd point, and now strong evidences are seen of determined efforts on the part of the corporations to control their telephone exchanges. Up to the present time, these have been conducted chiefly by the National Telephone Company, though the postal authorities, or the government, own the trunk lines between the cities. One of the latest corporations to be affected by this craze is Glasgow, and a letter has been received from the Postmaster-General setting forth the conditions on which a license will be granted for a municipal telephone exchange, and stating that if these conditions are adhered to (and they are simple enough), he is willing to grant the license from the earliest period possible to December 31, 1913. It is not stated, but it is to be presumed, that at that time the post office would have the right to take over the exchange, and that thus in time the whole telephone business of the country would lapse into the hands of the government. The National Telephone Company offered to meet the committee, and afford any further information, but was asked whether they were prepared to modify their present charges. It seems, therefore, fairly possible that Glasgow will either have lower telephone charges or else the corporation will put in a municipal telephone exchange, and the city will be in the throes of having two telephone exchanges, the annoyance of which is well known to many cities in the United States.

FOREIGN NOTES.

City of Mexico, Mexico, Jan. 8, 1900.

At a recent meeting of the stockholders of the Federal District Street Railway Company, held in this city, the resignation of the old board of directors was presented and accepted, and a new board, consisting of the following prominent business men of the City of Mexico, was elected: J. Casasus, Pablo Escandon, Capt. Porfirio Diaz and Chandon Stanhope. Nineteen thousand out of the twenty thousand shares of stock were represented at the meeting. Capt. Diaz is a son of President Porfirio Diaz, of Mexico. The company has many important improvements of the street railway system now under way, and this work will be pushed to a rapid completion.

General News.

THE TELEGRAPH AND TELEPHONE.

MOSCOW, POLK COUNTY, TEXAS.—The Southeast Texas Telephone Company has completed its line to this place.

RUSSELLVILLE, KY.—The East Tennessee Telephone Company notified their patrons that they had raised the rates 50 cents per month, and immediately every merchant, but four, in the city, and numerous private residences, ordered their instruments out.

HIGHLAND MILLS, N. Y.—The Highland Telephone Company, of Highland Mills, Orange County, has been incorporated to conduct a telephone system in Orange, Delaware, Ulster and other counties. Capital, $2000. Directors, J. W. Cummin, of Cornwall, and W. S. Russell and Henry M. Fitch, of Highland Mills.

NEW HAVEN, IND.—The New Haven Home Telephone Company, which was recently organized here, is building 10 miles of line, and will use the system of the American Electric Telephone Company, of Chicago. The officers of the company are: George W. Miller, president; George F. Frier, vice-president, and D. H. F. Berberick, secretary and treasurer.

MONTCLAIR, N. J.—The Montclair & Bloomfield Telephone Company, conducting an independent telephone system with lines running to Paterson, it is stated, has been sold to the Telephone, Telegraph & Cable Company of America, the new independent telephone combination which proposes to establish a long distance as well as a local independent telephone system.

CLEVELAND, OHIO.—The Cleveland Telephone Company will, on April 1, make heavy reductions in the rates for all the different classes of its service. The business telephones, for which $96 has been charged, will be reduced to $84. The Cuyahoga Telephone Company, the new independent system, which has just been established here, a few days ago announced its rates as $48 for business telephones and $36 for residence.

JERSEY CITY, N. J.—The Midland Telephone & Telegraph Company has been incorporated in this city. The capital stock is $15,000. The incorporators are Edward J. Hale, Melville Eggleston and James C. Vale, of New Jersey, and Alfred E. Holcomb, of New York. The purpose of the company is to construct telephone and telegraph lines from Hudson County to the Delaware River. The capital stock may be increased if necessary.

GREENWICH, CONN.—The New York Telephone Company, which controls the service in Greenwich, has sent notice to its subscribers here that rates will be reduced from $30 to $24 a year for telephones. The company has the monopoly of the business and its voluntary reduction of rates meets with general commendation. The company is building lines from Greenwich north into New York state, and by spring will cover territory heretofore without telephone service.

ATLANTIC CITY, N. J.—The Atlantic Coast Telephone Company, of which Louis Kuehle is president, and R. B. Hazlett is general manager, and in which prominent Philadelphia and Atlantic City capitalists are interested, will soon provide Atlantic City and adjacent towns with an improved and cheaper telephone service. The annual rate for standard instruments will be $36 for busi-

ness houses and $24 for residences, a very material reduction over present charges by the old company doing business here.

NEW MEXICO.—The Southwestern Telephone Company has been incorporated in Santa Fe, N. M., to operate under Bell telephone patents. It has a nominal capital of $25,000. This company will build during the present year 250 miles of long distance lines.

BOSTON.—The New England Telephone & Telegraph Company has announced its intention to put into force on Feb. 1 a reduction equivalent to one-third of the list rates on all telephones used by city officers and city officials in all places where the company has conduits in the streets. The present reduction allowed is one-quarter.

NEW YORK, N. Y.—The New York & New Jersey Telephone Company and the Postal Telegraph Company are extending their lines through Long Island. The former has given out contracts for building a new trunk line from Brooklyn to Riverhead. Seven new central offices are to be opened in the Borough of Queens. The company is to expend nearly $2,000,000 in improvements on Long Island. The Postal Telegraph Company has nearly completed its line through Brooklyn, Queens and Nassau counties, and a part of Suffolk to Fire Island.

TORONTO, ONT.—The independent telephone movement has reached Canada, and the formation of the Dodge Telephone Company has already been completed. In its announcement, the company states that it is a perfectly independent company, which will be operated in opposition to the Bell system. Its capital stock is $3,000,000, which is divided into $1,500,000 8 per cent. cumulative preferred stock, and the balance is common. The promotion of the Dodge Company is being done in Toronto, where the main offices will be located. An offer is being made of $1,000,000 of the preferred stock, which will be utilized in the construction of the lines in some of the leading centres of population.

ELECTRIC LIGHT AND POWER.

NEW HAVEN, IND.—There is an opening here for an electric light plant.

CHELSEA, IOWA.—There is a movement on foot at Chelsea for an electric light plant.

TRENTON, N. J.—The United Water, Gas & Electric Company is said to have absorbed all the water and lighting companies in the vicinity of Sunbury.

PUEBLO, COLO.—The Pueblo Light, Heat & Power Company has been incorporated by W. A. V. Rice, J. O. Albert, both of Pueblo.

MAUMEE, OHIO.—The Maumee Electric Company has been incorporated with a capital of $7500. Incorporators, W. R. Tryon, W. S. Swan, G. B Monen, A. C. Tryon, A. E. Tryon.

JENNINGS, LA.—The town council of Jennings granted to the representative of the Westinghouse Company a franchise to erect, equip and operate an electric light plant in Jennings.

PHILADELPHIA, PA.—The Dunbar Electric Company has been incorporated. Capital, $5000. Incorporators, W. M. Kitzmiller, J. McMullan, J. M. Shimer, H. Dixson, W. Drost, all of Philadelphia.

CEDAR RAPIDS, IOWA.—The Cedar Rapids Electric Light & Power Company filed articles of amendment increasing its capital stock from $15,000 to $500,000. C. J. Ives is president and I. Smith, secretary.

HOBOKEN, N. J.—The Municipal Light, Heat & Power Company has filed articles of incorporation at Jersey City. The capital stock is $300,000. The incorporators are John Bruning, Joseph Walsh and others.

CHICAGO, ILL.—The electric light plants of 12 towns between Evanston and Waukegan, a distance of 27 miles, are said to be planning to consolidate with $500,000 capital. Milwaukee men are behind the enterprise.

WILMINGTON, DEL.—The People's Light, Heat & Power Company, composed of Wilmington and Philadelphia capitalists, has been organized to construct an electric light and power plant in this city. Capital, $2,000,000.

COLD SPRING, N. Y.—The Cold Spring Light, Heat & Power Company, G. F. Brockman, general manager, are taking out an old style 75-light open arc machine and installing a Westinghouse 75-arc lighter, 1200-cp, of latest type.

DES MOINES, IOWA.—The Cedar Rapids Electric Light & Power Company has been incorporated. Capital, $500,000. Incorporators, C. J. Ives, I. B. Smith, J. H. Smith, W. G. Dows, W. D. Douglass, W. J. Greene, all of Cedar Rapids.

NEW YORK, N. Y.—The River District Light, Heat & Power Company, of New York City, has been incorporated. Capital, $50,000. Directors, James Douglass, Cleveland; H. Dodge, E. M. Johnson, William H. Yale and John Jay McKelvey, of New York City.

CASEY, ILL.—The city council has awarded the contract for the erection of a joint system of water works and electric lights to the Commercial Electric Company, of Chicago, at a cost of $36,000, the plant to be completed and turned over to the city June 15, 1900.

MANCHESTER, COLO.—The Manchester Light, Heat & Power Company has been organized here. Capital, $15,000. Incorporators, R. W. Jewell, H. L. Beardslee, M. F. Le Roy, J. Hutchins, A. Wolff, L. Mathews, M. Beehler, R. R. Robinson, all of Manchester.

PHILADELPHIA, PA.—A new electric lighting plant is contemplated at Asbury Park, N. J., by the authorities of that place. It will be equipped with three engines and three dynamos of 70 lights' capacity; one additional boiler of 200-hp will also be required, in addition to the building, which will be brick and iron. Cost, $25,000.

BATTLE CREEK, MICH.—The Kalamazoo Valley Electrical Company, which intends to transmit power from the big dam at Allegan to Kalamazoo, Battle Creek, Marshall, Albion and Jackson, now asks a franchise from this city for 30 years. They offer to place their poles 10 feet higher than any others now in use in the city and to give the city power free for operating the fire alarm system and police alarm system. The wires have already reached this city. The franchise will be granted.

THE ELECTRIC RAILWAY.

LANCASTER, PA.—A trolley road will be built from Lancaster to New Holland in the spring.

DEKALB, ILL.—A franchise has been granted to the Sycamore-DeKalb Electric Railway Company by the city council.

WILMINGTON, DEL.—A semi-annual dividend of 2 per cent. has been declared by the Wilmington & New Castle Railway Company.

SPARTANBURG, S. C.—The Spartanburg Railway & Electric Light Company has been incorporated. Capital, $150,000. Incorporators, F. D. McEwen, P. H. Gadsden.

ALBANY, N. Y.—The New York & Brooklyn Union Transportation Company was incorporated to construct a railway, for either compressed air or electricity, between Manhattan and Brooklyn.

ATLANTA, GA.—The Atlantic & Western Electric Railway has been incorporated to build a 45-mile line from Atlanta to Douglasville, Ga., a portion of the route of Sherman's famous march to the sea.

CASCADE TUNNEL.—The great Cascade tunnel of the Great Northern, 13,253 feet long and costing over $3,000,000, will be finished within this year. The cars running through it will be operated by electricity.

SCRANTON, PA.—The Delaware, Lackawanna & Western Railroad has equipped 16 locomotives with electric headlights. The Lackawanna is the first eastern road to use this style of light. Storage batteries are used.

BOSTON ELEVATED.—The selectmen of the town of Brookline, Mass., have granted locations to the Boston Elevated Railway Company for the laying of a double track street railway in Boylston, Cypress and Harvard streets and Brookline Avenue, Brookline, Mass.

NEW YORK, N. Y.—It is stated that the New York, Westchester & Connecticut Traction Company desires to enter North Pelham, and is asking for a franchise which would parallel lines of its rival, the Union, or "Huckleberry," Railway. The application will be considered by the village trustees on Feb. 5.

ALBANY, N. Y.—The state railroad commission has refused to grant the application of the Syracuse, Skaneateles & Moravia Railroad for permission to build an electric railroad from Moravia to Syracuse, a distance of 40 miles. The board does not believe that public convenience and necessity require the road.

YORK, PA.—The York Traction Company was organized by Judge W. F. Bay Stewart, Capt. William H. Lanius, president of the York extension of the Western Maryland Railroad; William A. Himes, of New Oxford, Pa.; Grier Hersh, president of the York National Bank; John W. Steacy, George P. Smyser and George S. Billmeyer.

MAMARONECK, N. Y.—The war between the village trustees and the Westchester Electric Railway Company, which has been on for a week, was brought to a close by the parties entering into a compromise. The company and the village trustees agreed that the building of the road should be allowed to go on under certain conditions.

ATLANTIC CITY, N. J.—A syndicate is being formed at Atlantic City, N. J., with a capital of $200,000, which proposes to erect car barns, power houses, repair shops, etc., in connection with a new trolley road, to be built from Absecon to Somer's Point, N. J. The same parties are contemplating the construction of a new road to run from Atlantic City to Pleasantville, N. J.

SAGINAW, MICH.—Articles of association of the Saginaw Southern Electric Railway have been sent to Lansing, the object being to construct an electric railroad to St. Charles and Chesaning. The franchises and right of way have been nearly all secured for the entire distance, and the new line will traverse the newly developing coal fields in the southern section of the county.

LANCASTER, PA.—The Conestoga Traction Company, which controls all the trolley lines in this county, has effected a permanent organization. The officers are: President, William B. Given, Columbia; treasurer, Oscar M. Hoffman, Columbia; directors, William B. Given, J. W. B. Bausman, John D. Skiles, Eugene G. Smith, Lancaster; Samuel R. Shipley, W. B. Kurtz, Philadelphia.

SCRANTON, PA.—Judge Savage, specially presiding in equity court here, decreed that the Carbondale Traction Company is in default to the Real Estate Trust Company, of Philadelphia, in the sum of $358,016, and ordered that the road be sold for the benefit of the bondholders, if the obligations are not discharged before Jan. 15 next. Ex-Judge E. N. Willard was appointed special master to conduct the possible sale.

ALBANY, N. Y.—The South Brooklyn Railway Company, of Brooklyn, has been incorporated with a capital of $150,000, to build and operate a line of railroad, 12 miles long, by steam or electric power. The road is to be used mainly for summer travel. The directors are W. Bayard Cutting, John F. Ambrose, J. Archibald Murray, J. E. Tucker and N. R. Cottman, of New York City; John D. Miller, Jr., and George W. Giddings, of Brooklyn, and Francis H. Bergen, of New Brighton.

ALBANY, N. Y.—The United Traction Company, formed by merging the Albany and Troy City and Cohoes railways, has authorized the issue of $1,000,000 in new stock with which to pay for re-equipping the Troy division, improvement of property and retirement of old Troy City debentures. F. N. Mann, Jr., of Troy, was named vice-president, to succeed Charles Cleminshaw, resigned. The directors decided to purchase 25 new open cars and 35 box cars. The past month's receipts show a gain of $9992. The capital of the company will be $5,000,000.

MENOMINEE, MICH.—Several Menominee County capitalists are considering the plan of building a street car line through the county at least to Powers. If built to the county line a connection with the Escanaba line would be made. This would afford the people of Menominee and vicinity a direct route to Escanaba and Wells, Mich. The plan is a most feasible one, and the project is being earnestly agitated throughout the county. It would necessitate the expenditure of nearly $200,000. Among those who are interested are Ira Carley, of Ingalls, and J. T. Werriline, of Nadeau.

HEMPSTEAD, N. Y.—The highway commissioners have granted a franchise for two trolley lines through that portion of Nassau County within the town of Hempstead. The Mineola, Hempstead & Freeport Traction Company has received the right to construct a road from Mineola south through the village of Hempstead to Freeport on Great South Bay. This company will begin the construction of its line immediately, and it will be running by early spring. The Nassau Traction Company has received a franchise to run through other parts of the town. This line will connect with Long Beach.

NEW COMPANIES.

HACKENSACK, N. J.—The Cos Cob Motor & Launch Company was incorporated on Jan. 25 by J. T. Smith, F. H. L. Sneckner, L. P. Sneckner and John A. O'Neil. The capital is $50,000. The company will build motors and launches.

THE ACME ELECTRICAL COMPANY, of New York City, has been incorporated to manufacture and sell electrical apparatus. Capital, $25,000. Directors, George H. Crossman, Louis A. Jackson and Charles A. Secor, of New York City.

MORGAN ELECTRICAL MACHINE COMPANY, of Chicago, has been incorporated with a capital stock of $5000. Incorporators, Edmund C. Morgan, D. B. Douglas and James H. Barnard.

OBITUARY.

MR. D. A. DEVENDORF.—We regret to note the recent death of Mr. Dewitt A. Devendorf, secretary and general manager of the Empire State Power Company, which is putting in an extensive plant at Schoharie Falls. He and his father were among the chief promoters of this enterprise. He was only 36 years of age, and was highly esteemed in Amsterdam.

MR. T. L. REED.—We regret to announce the death of Mr. Thomas L. Reed, at Providence, R. I., on Jan. 22. He was one of the pioneers in the modern art of making office, annunciator, underwriter and weatherproof insulated wire. He is said to have been the inventor and patentee of the first successful flexible gastight tubing, into the composition of which there entered animal membrane. Also he was the first, it is stated, to vulcanize successfully the rubber bulb now used extensively in many arts. He was considered a great expert on rubber and rubber compounds. He left a daughter and three sons, who occupy prominent positions in the financial and commercial world.

GEORGE C. HERSCHELL.—The death is announced, with deep regret, of George C. Herschell, the managing head of the extensive manufacturing firm of Armitage-Herschell Company, of North Tonawanda. He was ill for several months last year with typhoid fever and erysipelas. To the surprise of all he eventually rallied, and a short time ago returned to his accustomed place in the pursuit of business. On the 7th inst. he was again attacked with erysipelas, and it proved fatal after but a few days' duration. The deceased was a native of Scotland, and had been in business at Tonawanda for 26 years. The firm has consisted of Messrs. James Armitage, George and Allan Herschell, and from a small beginning in the way of practical machinists, founders and boilermakers, they grew into a concern of generous dimensions, sending their products in the shape of merry-go-rounds and electric appliances to all portions of the inhabited globe. In all the relations of life the deceased was a model citizen, possessed of those sterling qualities of head and heart so desirable in a business man. He was 52 years of age and leaves a widow and four children.

Trade and Industrial Notes.

MESSRS. D. L. BATES & BRO., Dayton, Ohio, have issued a booklet on the "Bates" ceiling fan motors, wound for direct or alternating current. The firm manufactures desk fans also, but they are wound for direct current only.

THE "G-I" COMPANY, as it is popularly known, has brought out another booklet, which summarizes in an attractive manner the uses and results of the Wright discount meter. Actual figures supplied from the statistics of many foremost concerns make exceedingly attractive reading.

JUNCTION BOXES.—Messrs. Johnston & Morton, Utica, N. Y., have issued a pamphlet on their panel boards, junction boxes and switchboards. Their new type standard junction boxes are made of wood or iron, as desired, and all boxes are lined with black enameled slate. The various devices covered by the title of the pamphlet are illustrated.

THE CHICAGO PNEUMATIC TOOL COMPANY, Chicago, Ill., has issued a book of 100 pages, giving illustrations of the uses of pneumatic riveters, hammers and drills and reproductions of testimonial letters from many users of these handy devices. This company manufactures the Boyer and new Boyer pneumatic hammers, and a complete line of devices in which compressed air is the driving power.

THE ROLLINS ENGINE COMPANY, Nashua, N. H., has issued, under the title of "A Handful of Trumps," a pamphlet containing copies of testimonial letters regarding Rollins' engines. The letters express satisfaction with the performances of the engines. These engines are designed to withstand the strain incident to higher steam pressure, increased speeds and variable loads, and are claimed to be up-to-date in all respects.

THE WESTERN ELECTRICAL SUPPLY COMPANY, of St. Louis, Mo., are sending out to the trade a catalogue devoted exclusively to pushes and push buttons of all kinds and descriptions. It is a handsomely bound and well arranged catalogue of 40 pages, and covers all the latest ideas in pushes, plates, etc. Anyone interested in house goods or indoor electrical construction would do well to secure a copy, which can be had on application.

THE WARREN ELECTRIC & SPECIALTY COMPANY, Warren, Ohio, showed its enterprise in quest of business by sending two representatives to the convention of the Northwestern Electrical Association, which was held in Milwaukee, Jan. 17, 18 and 19. These two gentlemen performed excellent work in behalf of the company's Peerless transformers and other well known products, the merits of which were well expounded to the interested delegates at the convention.

MESSRS. CHARLES H. BESLY & CO., 10 and 12 North Canal Street Chicago, Ill., manufacturers and dealers in machinists' hardware, report a very successful business for the year 1899, just closed; a marked improvement being noted in the demand for specialties of their own manufacture, viz., taps of all descriptions, Badger & Gardner die stocks, parallel clamps, Helmet sheet bronze and wire for springs, Perfection and Bonanza oil cups, Gardner grinders, their Helmet solid oil and Mannocitin, a rust preventive. Business for the new year has started in briskly and they regard the outlook for the future very bright.

STURTEVANT EXHAUST HEAD.—The efficiency of the Sturtevant exhaust head is emphatically shown by the following letter, received by the B. F. Sturtevant Company, of Boston, from the Frost & Wood Company, of Smith's Falls, Ont. It reads: "Allow us to add that we have never paid with greater satisfaction an account for an article of this description than we paid for your steam exhaust head. It has given us every satisfaction, and we would not be without it for several times what it cost. It should prove invaluable to steam users in a cold climate. Previous to using this we were greatly bothered with an accumulation of ice from the exhaust spray. This has now been entirely overcome."

THE MIETZ & WEISS ENGINE.—Mr. August Mietz, 128 Mott Street, New York, manufacturer of the Mietz & Weiss gas or kerosene engine, has just issued a pamphlet illustrating and describing this type of machine. The main features and advantages of the engine are briefly pointed out, and may be summarized as follows: No loss of time in getting up steam; safety; reliability; no dangerous gasolene, naphtha or benzine used; not affected by changes of temperature; easily started and managed; perfect and reliable ignition; automatic lubrication; consumption of fuel regulated by automatic governor in proportion to power required. Various applications of these engines are illustrated, together with diagrams, showing some special features of the engine. At the back of the pamphlet are given copies of many letters from users of these engines, which testify to much satisfaction from their use.

AULTMAN ROCK CRUSHER.—The Aultman Company, of Canton, Ohio, is manufacturing a rock crusher which is said to be highly satisfactory in use, 300 of them having already been sold. This machine, which is the invention of Mr. Martin Hogan, is simple in construction, very durable and of great capacity. It is always doing work, instead of one-half the time, as in machines in which the jaw swings from a pivotal point, whether top, bottom or middle. The crushing movement is so continuous that the material works down and out without stopping. The crusher is economical in the use of power, as has been demonstrated by repeated tests. It has been established by these tests that the power required is less than 1-hp for one ton of capacity per hour on material of average weight and hardness, reduced to pass a 2½-inch ring. The Aultman Company is now prepared to meet the full requirements of both domestic and export trade.

FOREIGN AND DOMESTIC ELECTRICAL MANUFACTURERS are all appreciative of a good machine tool. The Cincinnati Milling Machine Company have made known the fact that their machine is applicable to electrical manufacturing and they have recently shipped machines to Societe Electricite Automobile, Mors, Societe d'Electricite Alioth, Lyon; Westinghouse Company, Havre; the Stanley Electrical Manufacturing Company, Pittsfield, Mass.; General Electric Company, Westinghouse Electric & Manufacturing Company, Siemens & Halske Elec. Company, Bullock Elec. Company, etc. Moreover the leading automobile builders in the country have placed orders with this company, and as it is the common experience of the company that wherever their machines are once installed it is certain of subsequent orders for any milling machines wanted, it is apparent that the "Cincinnati Miller" will soon be a familiar machine to all the manufacturers in the electrical field.

STEPHENSON BAR BELT DRESSING.—The Stephenson Manufacturing Company, Albany, N. Y., states that the demand for the Stephenson bar belt dressing manufactured by it has shown a steady large increase ever since it was first placed upon the market in 1888. It derives the name "bar" from its shape, being put up in sticks. It is nearly solid, and is applied by simply holding it against the moving belt. The results are instantaneous. The claims made for it are that it cleans and preserves leather belts, will not injure rubber or cotton and causes the belts to adhere more firmly to the pulley, thus preventing slippage. Belts that are dirty, dry and out of condition often entail a loss in transmission of from 20 to 30 per cent. The Bar Belt Dressing regains the loss. It is sent by mail, and all who are interested in the transmission of power by belts and would like to test this dressing can obtain a free sample by applying to the company.

THE EMERSON ELECTRIC MANUFACTURING COMPANY report that their catalogue, No. 2110, is now in the hands of the printer and will be ready for distribution within a week or 10 days. It describes alternating current fan motors and ceiling fans of the 1900 model and the company feel confident that their 1900 model motors will be even more satisfactory than the highly improved machines placed on the market by them in 1899. As the main office of the Emerson Electric Manufacturing Company is located in St. Louis, Mo., they have been unable to serve their eastern customers as promptly as they would desire, and have consequently opened a branch office at 136 Liberty Street, New York City, where they will carry a large stock of all regular motors for prompt shipment from New York. This office is in charge of one of the officers of the Emerson Company, who is permanently located in New York, devoting his entire time to the needs of the eastern trade. Any inquiries in regard to the new model Emerson motors addressed to the branch office at 136 Liberty Street, New York City, or to the main office in St. Louis, Mo., will receive prompt attention.

Record of Electrical Patents.

UNITED STATES PATENTS, ISSUED JAN. 23, 1900.

[Conducted by Wm. A. Rosenbaum, Patent Attorney, Times Building, N. Y.]

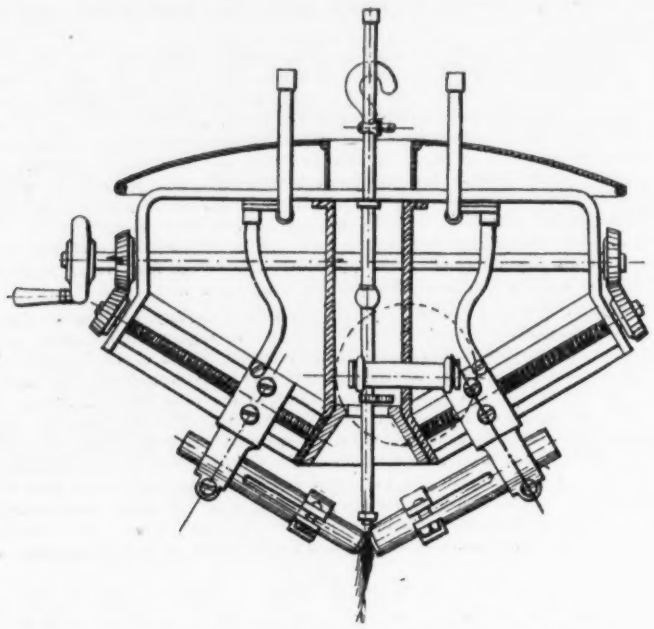
641,682. DYNAMO-ELECTRIC MACHINE; W. L. R. Emmet, Schenectady, N. Y. App. filed Dec. 16, 1898. (See Current News and Notes.)

641,721. TELEPHONE EXCHANGE SYSTEM; F. R. McBerty, Downer's Grove, Ill. App. filed Nov. 24, 1896. (See Current News and Notes.)

641,737. REGISTERING APPARATUS AND CIRCUITS FOR TELEPHONIC MEASURED SERVICE; G. K. Thompson, Malden, Mass. App. filed June 15, 1899. (See Current News and Notes.)

641,743. TELEPHONE SWITCHBOARD APPARATUS AND APPLIANCE; T. C. Wales, Jr., Newton, Mass. App. filed July 5, 1899. (See Current News and Notes.)

641,767. METHOD OF ELECTRIC ARC HEATING AND APPARATUS THEREFOR; H. Drösse, Berlin, Germany. App. filed Dec. 13, 1898. A blast tube is used for discharging air or gas against the arc and is arranged so that the direction of the discharge may be altered. The idea is to compensate for the irregular consumption of the carbons.



641,767.—Method of Electric Arc Heating and Apparatus Therefor.

641,829. ELECTRIC OVERHEAD RAILWAY; L. J. Bruns and H. R. Ottesen, Hanover, Germany. App. filed Aug. 15, 1899. The car rests upon three overhead rails supported upon posts, the invention residing in certain details of construction.

641,843. PNEUMATIC CONTROLLING SYSTEM FOR ELECTRIC RAILWAY CARS; W. Cooper, Cincinnati, Ohio. App. filed June 23, 1898. This is the "multiple unit" system of control carried out by the aid of compressed air, such power being used to operate the electrical controllers on each car and the arrangement being such that any car or the entire train may be controlled from either platform of a car.

641,853. WIRE JOINT; A. Gartner, Paterson, N. J. App. filed Nov. 27, 1899. The joint consists of two metal tubes secured together lengthwise, one end of the one tube extending beyond the corresponding end of the other, said tube being adapted to receive the wires from opposite directions and to be twisted together with said wires, the end portion of each wire extending through and beyond its respective tube, and coiled around the end portion of the other tube.

641,879. SURFACE CONTACT ELECTRIC RAILWAY SYSTEM; J. McL. Murphy, of Torrington, Conn. App. filed Feb. 7, 1899. This invention, which is applicable to the safety third-rail system, is an improvement in the box switches.

641,890. ELECTRIC FOOT BATTERY; D. W. Prosser, of Jamestown, N. Y. App. filed Nov. 6, 1899. A silver and copper plate are connected and act against a zinc plate, the plates being inserted in the insole of a shoe.

641,891. ELECTRIC ARC LAMP; E. W. Rice, Jr., Schenectady, N. Y. App. filed Aug. 7, 1899. (See Current News and Notes.)

641,903. SYSTEM OF ELECTRICAL DISTRIBUTION; C. P. Steinmetz. Schenectady, N. Y. App. filed Sept. 30, 1899. (See Current News and Notes.)

641,916. PRINTING TELEGRAPH INSTRUMENT; J. E. Wright, New York, N. Y. App. filed May 5, 1899. This invention is an improvement upon patent No. 494,185, and consists of a shaft having four spiral grooves operated in connection with a type wheel carriage for imparting an intermittent movement to the type wheel.

641,924. FIRE ALARM BOX; H. B. Blackwell, Jr., New York, N. Y. App. filed Aug. 24, 1899. This invention provides, in the same box with the public signal, an auxiliary or a series of auxiliary signal devices of different signal numbers and adapted to be thrown into circuit from different buildings, so that a signal turned in will indicate the particular building connected with the box in which a fire may be located.

641,927. QUICK BRAKE ELECTRIC SWITCH; W. F. Bossert and G. L. Holton, Utica, N. Y. App. filed March 7, 1899. This switch is constructed so that a spring must be compressed to a determinate degree prior to the release of a locking device which detains the blade.

641,950. ELECTRIC FIRE ALARM SYSTEM; M. Garl, Akron, Ohio. App. filed Sept. 12, 1899. With this system an alarm is sounded at a central station and also at a point near the conflagration. One feature of the invention being the provision of means for firing a blank cartridge which will give a sufficiently loud report to waken a heavy sleeper.

641,957. ELECTRIC LIGHTING APPARATUS; G. Heidel, St. Louis, Mo. App. filed Feb. 20, 1899. The invention consists of the mechanical connection between the connecting rod of a windmill and the shaft of a dynamo.

641,958. PENCIL FOR ELECTRIC ARC LAMPS; G. Heidel, St. Louis, Mo. App. filed March 16, 1899. (See Current News and Notes.)

642,021. CIRCUIT CHANGER; A. A. Vanderpool, Newark. App. filed March 25, 1899. Improved details of construction facilitating the application of the device to a door jamb and affording a neat arrangement of parts as well as effective operation.

11,804. (Reissue.) SYSTEM OF STOPPING STEAM ENGINES; A. J. Purinton and J. R. Reynolds, Hartford, Conn. App. filed Dec. 22, 1899; original number 635,080, dated Oct. 17, 1899. An electromagnetic stop is connected with the throttle valve, and an electromagnetic vacuum breaker is connected with the condenser, so that the steam supply will be cut off and the vacuum destroyed, simultaneously.

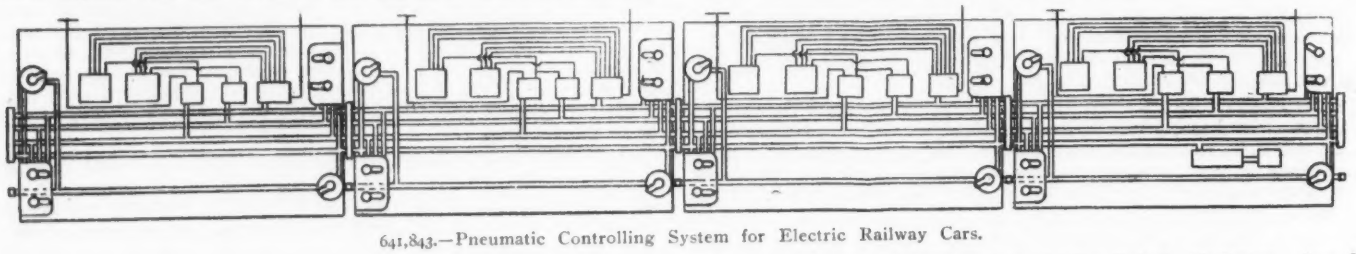
GERMAN PATENTS, ISSUED JAN. 10, 1900.

[In Charge of Dr. Ralph Julian Sachers, 120 Liberty Street, New York.]

105,939. SOCKET FOR INCANDESCENT LAMPS; Siemens & Halske, Berlin. App. filed Aug.. 11, 1898. A base plate, consisting of three layers, is placed into the bottom of the lamp socket. The two outer layers are made of insulating material, the middle layer of metal. Each of the layers is provided with a central opening of different diameter, the upper layer having the largest, the lower the smallest diameter. The lamp itself is provided with a cylindrical contact piece having the exact diameter as the smallest opening. Should lamps of different current strength be used, the layer contact piece would make a short circuit between the contact piece and the mantel portion of the socket by means of the central layer of metal in the bottom part of the socket.

105,981. SYSTEM OF DISTRIBUTION; Allgemeine Electricitats-Gesellschaft, Berlin. App. filed Oct. 21, 1898. The system consists of four leads, three of which may form the positive lead, while the remaining fourth lead forms the negative lead.

105,982. SYSTEM OF DISTRIBUTION; Allgemeine Electricitats-Gesellschaft, Berlin. App. filed Oct. 21, 1898. For polyphase currents, two of the four leads are short-circuited, while for continuous current, one of these two leads is connected with one of the remaining ones.



641,843.—Pneumatic Controlling System for Electric Railway Cars.

106,231. GALVANIC BATTERY; John Laskey Dobell, Harlesden. App. filed Feb. 4, 1898. A furnace is provided with a kettle containing molten lead. Into the lead are suspended plates or rods of carbon or coke and a porous vessel containing a metal salt adapted to produce oxygen, which metal salt is melted similar to the lead, by the heat of the furnace. Air or any other oxidizing gas is introduced into the molten metal salt through a pipe, in order to supplant the oxygen, which by means of the electric current passes from the metal salt through the porous vessel into the molten lead in order to oxidize the carbon. Instead of the metal salt, a mixture of several salts may be used, as an alkaline salt, chromic acid and a surplus of an alkaline, with or without ixode of lead.